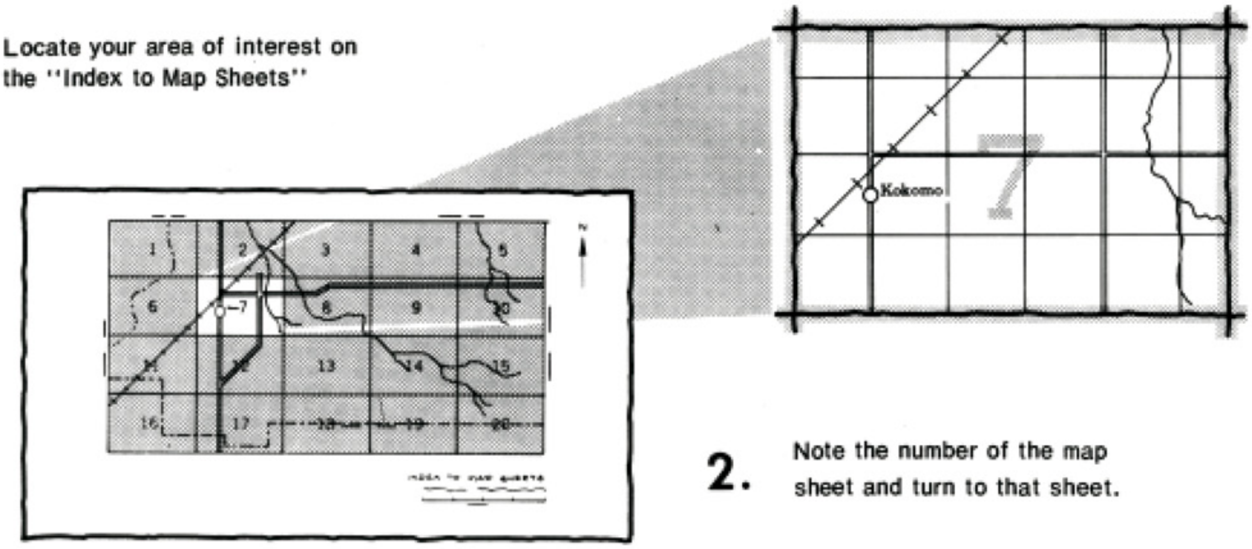
soil survey of Nemaha County Kansas

United States Department of Agriculture, Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

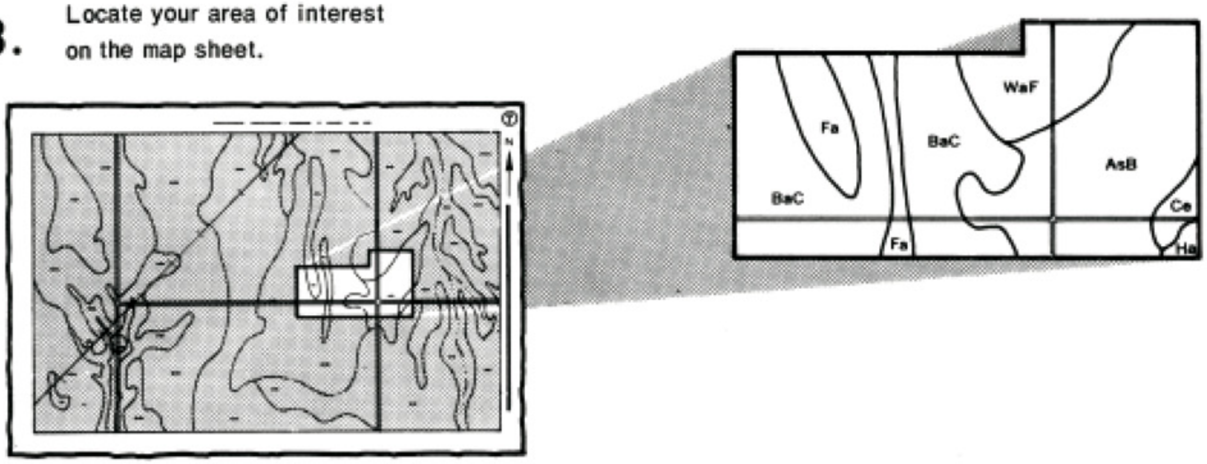
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"

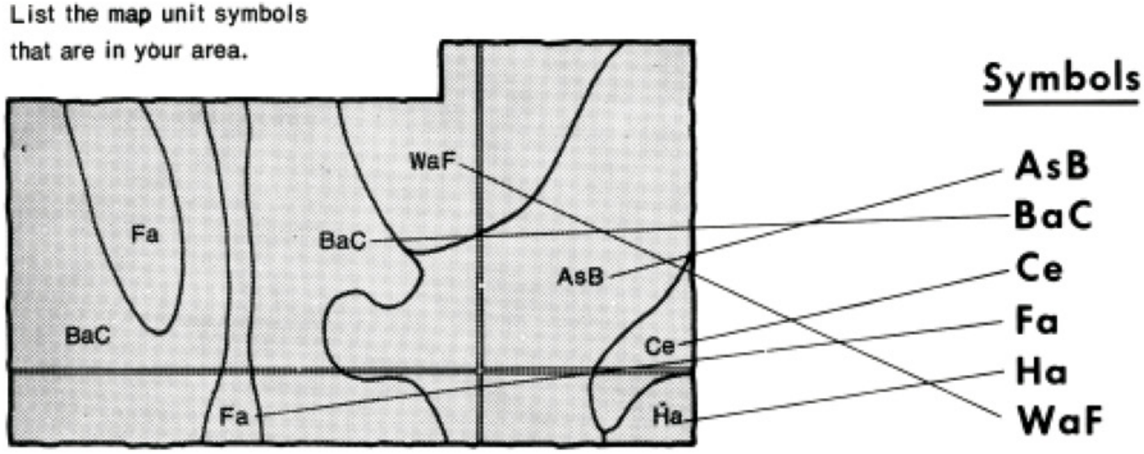


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.

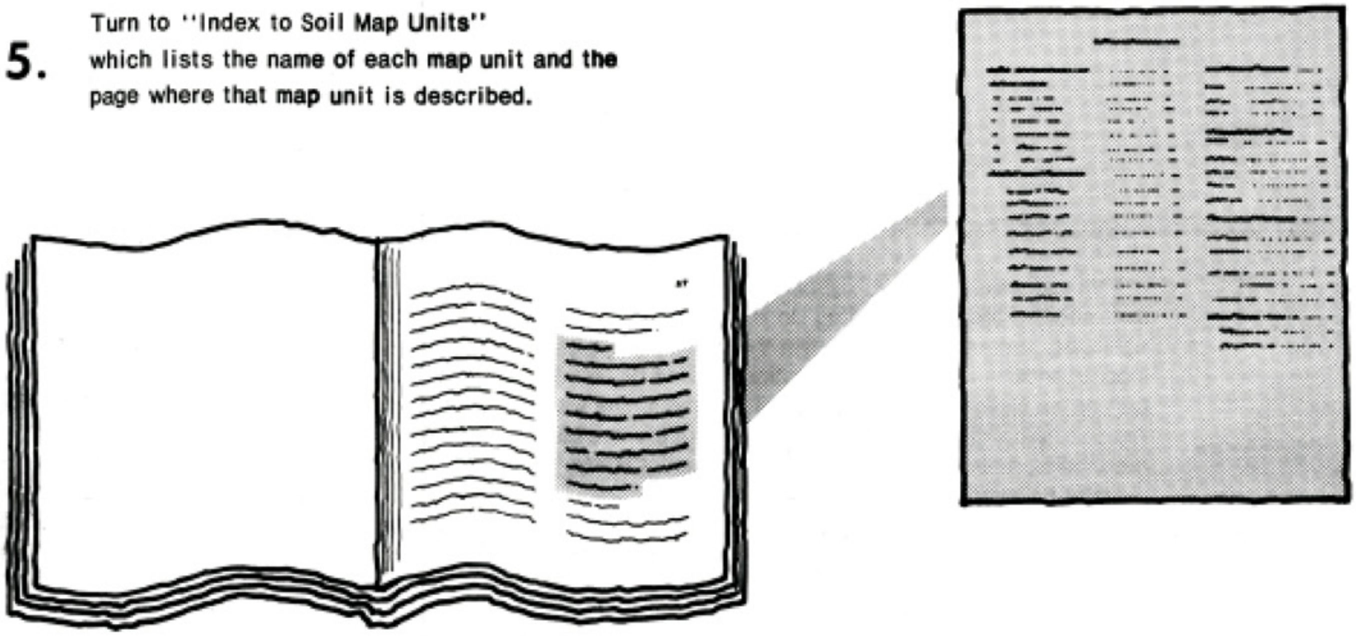


4. List the map unit symbols that are in your area.

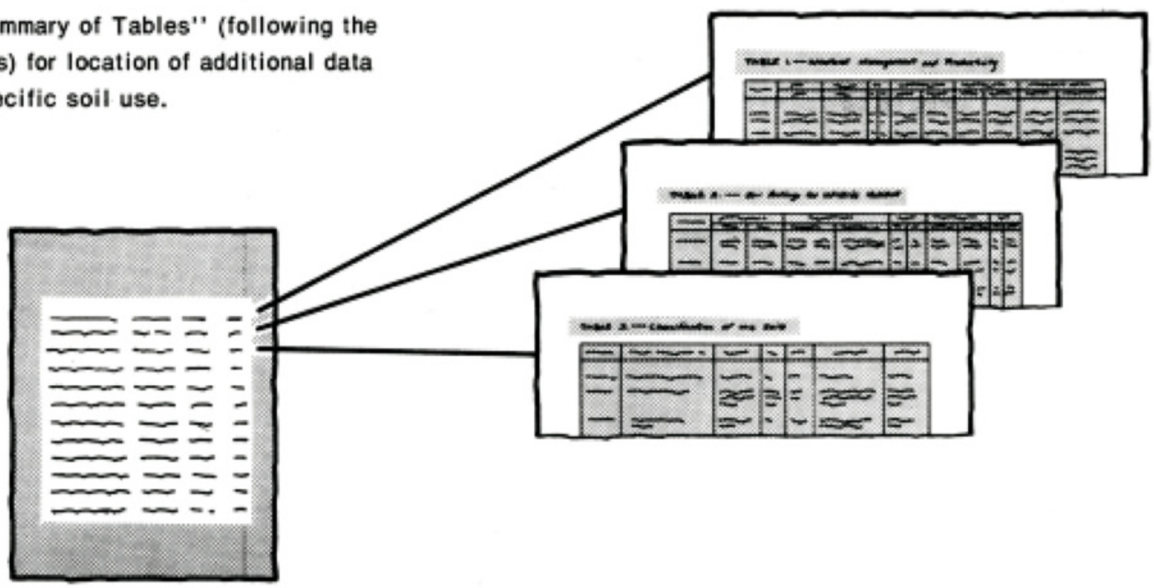


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Nemaha County Conservation District. Major fieldwork was performed in the period 1976-79. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Grain sorghum, a crop commonly grown on Pawnee, Burchard, and Steinauer soils.

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soil series

Issued February 1982

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foreword

This soil survey contains information that can be used in land-planning programs in Nemaha County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service

soil survey of
Nemaha County, Kansas

By Paul R. Kutnink, Donald A. Gier, Roger L. Haberman,
and Donald R. Jantz, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with the Kansas Agricultural Experiment Station

general nature of the county

NEMAHA COUNTY is in the northeastern part of Kansas (fig. 1). It is bordered on the north by Nebraska. It has a total area of 453,760 acres, or 709 square miles. The population was 11,962 in 1979. In that year, Seneca, the county seat, had a population of 2,469. The county was organized in 1865.

Nemaha County is in the Nebraska and Kansas Loess-Drift Hills land resource area. The soils generally are deep and gently sloping to moderately steep and have a clayey or loamy subsoil. Elevation ranges from 1,023 to 1,420 feet above sea level.

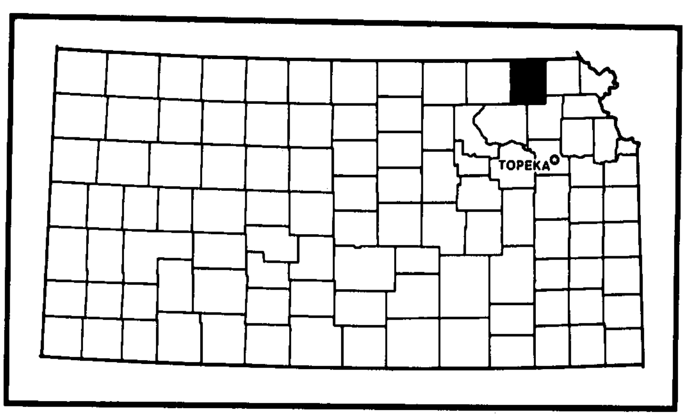

Figure 1.—Location of Nemaha County in Kansas.

Most of the county is drained by the Nemaha and Black Vermillion Rivers and Spring Creek, all of which are permanently flowing streams. The Nemaha River flows north, the Black Vermillion River west, and Spring Creek east.

The main enterprises in the county are farming, dairying, and swine raising. Sorghum, corn, soybeans, and wheat are the main crops.

climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Nemaha County is typical continental, as can be expected of a location in the interior of a large mass in the middle latitudes. Such climates are characterized by large daily and annual variations in temperature. Winter is cold because of the frequent outbreaks of polar air. It lasts from December through February. Warm summer temperatures last for about 6 months every year. They provide a long growing season for the crops commonly grown in the county. Spring and fall generally are short.

Nemaha County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it falls during late evening or nighttime thunderstorms. Although the total precipitation generally is adequate for any crop, its distribution causes problems in some years. Prolonged dry periods of several weeks are not uncommon during the growing season. A surplus

of precipitation often results in muddy fields and a delay in planting and harvesting.

Tornadoes and severe thunderstorms strike occasionally. These storms usually are local in extent and of short duration, so that risk damage is small. Hailstorms occur during the warmer part of the year, but they are infrequent and local in extent. They cause less crop damage than the hailstorms in western Kansas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Centralia in the period 1951 to 1976. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 29.6 degrees F, and the average daily minimum temperature is 18.8 degrees. The lowest temperature on record, which occurred at Centralia on January 4, 1947, is -35 degrees. In summer the average temperature is 76.1 degrees, and the average daily maximum temperature is 87.8 degrees. The highest recorded temperature, which occurred at Centralia on August 13, 1936, is 114 degrees.

The total annual precipitation is 34.43 inches. Of this, 25.20 inches, or 73 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 19.03 inches. The heaviest 1-day rainfall was 8.54 inches at Woodlawn on May 20, 1977.

Average annual snowfall is 21.9 inches. The greatest snowfall was 63.2 inches, during the winter of 1978-79. The greatest snow depth at any one time during the period of record was 28 inches on March 16, 1960. On an average of 24 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 76 percent of the time possible in summer and 63 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in April.

natural resources

Soil is the most important natural resource in the county. It provides a growing medium for crops and for the grass grazed by livestock.

Other mineral resources are sand, gravel, and limestone. Sand and gravel are available from deposits in the glacial till. Limestone is mined from residual limestone formations.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, it consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

1. Pawnee-Burchard-Steinauer association

Deep, gently sloping to moderately steep, moderately well drained or well drained soils that have a loamy or clayey subsoil; on uplands

This association is on narrow ridgetops and on side slopes. Most areas are drained by intermittent drainageways and creeks.

This association makes up about 58 percent of the county. It is about 41 percent Pawnee soils, 22 percent Burchard soils, 12 percent Steinauer soils, and 25 percent minor soils (fig. 2).

The moderately well drained Pawnee soils formed in glacial till on narrow ridgetops and side slopes. Typically, the surface layer is very dark brown clay loam or clay about 9 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, mottled, firm clay loam, and the lower part is dark grayish brown and grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is mixed light brownish gray and yellowish brown clay loam.

The well drained Burchard soils formed in glacial till on side slopes and narrow ridgetops. Typically, the surface layer is very dark grayish brown clay loam about 10 inches thick. The subsoil is firm clay loam about 27 inches thick. The upper part is dark yellowish brown, the next part is dark yellowish brown and yellowish brown, and the lower part is light brownish gray and mottled. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam.

The well drained Steinauer soils formed in glacial till on the side slopes. Typically, the surface layer is dark brown clay loam about 6 inches thick. The next 7 inches is olive brown, firm clay loam. The substratum to a depth of about 60 inches is mottled clay loam. It is pale brown in the upper part and grayish brown in the lower part.

Minor in this association are Kennebec, Olmitz, and Wymore soils. The silty Kennebec soils are on flood plains along drainageways and on the adjacent foot slopes. Olmitz soils are on foot slopes. They are similar to the Burchard soils. Wymore soils are on broad ridgetops and the upper side slopes. They are similar to the Pawnee soils.

This association is used mainly for cultivated crops, but some areas are used for hay, pasture, or range. Corn, grain sorghum, soybeans, and wheat are the main crops in the gently sloping and moderately sloping areas. Grain sorghum and wheat are the main crops in the strongly sloping areas. Erosion is a hazard. Controlling erosion and improving tilth and fertility are concerns in managing the major soils.

2. Wymore-Pawnee association

Deep, gently sloping or moderately sloping, moderately well drained soils that have a dominantly clayey subsoil; on uplands

This association is on ridgetops and on generally smooth side slopes. The broader, smoother ridgetops are uniform in elevation. The areas are drained by intermittent drainageways and creeks.

This association makes up about 35 percent of the county. It is about 44 percent Wymore soils, 42 percent Pawnee soils, and 14 percent minor soils (fig. 3).

The Wymore soils formed in loess on broad ridgetops and on side slopes. Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark brown and firm, the next part is very dark grayish brown and very firm, and the lower part is dark grayish brown, mottled, and firm. The substratum to a

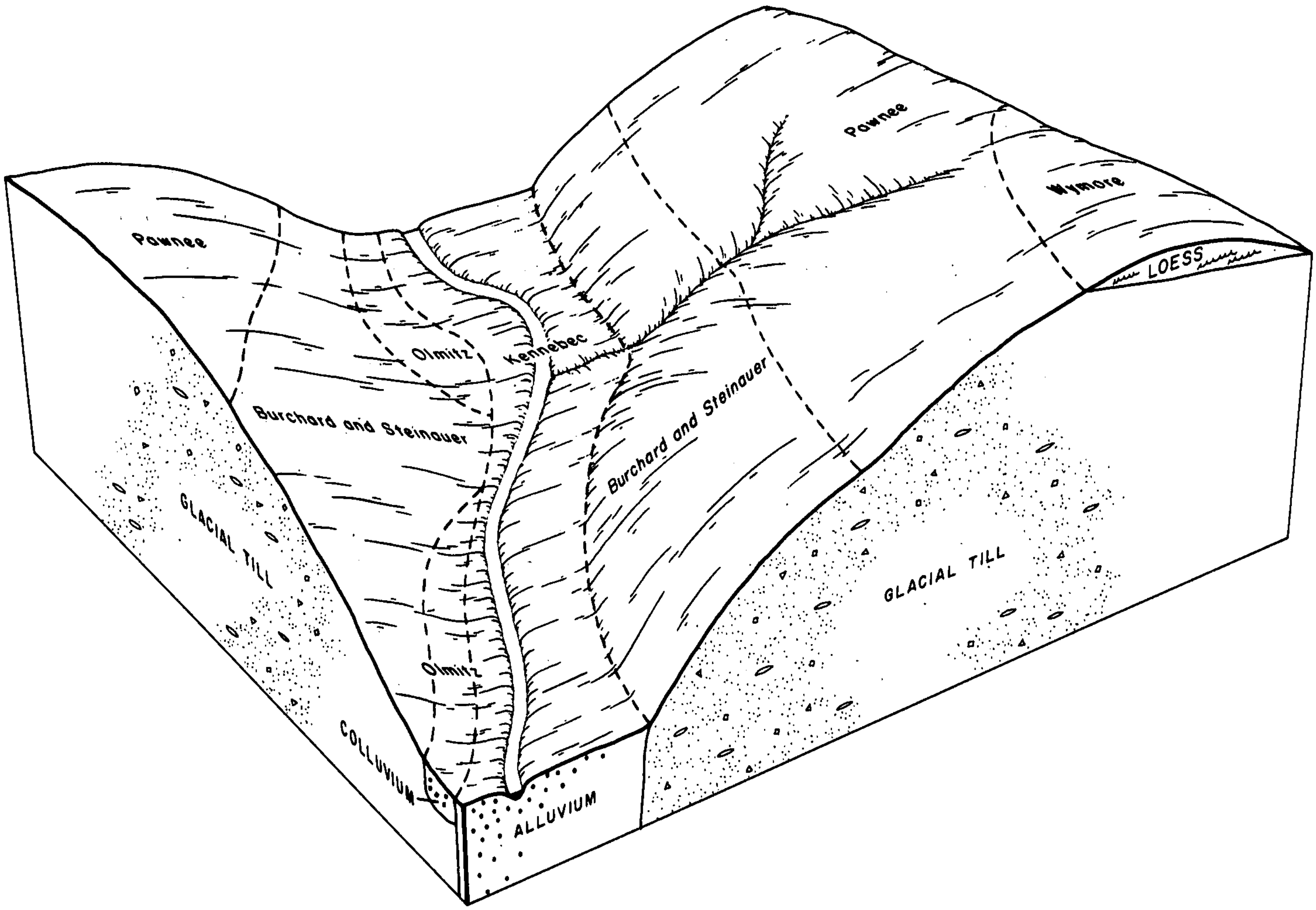

Figure 2.—Pattern of soils in the Pawnee-Burchard-Steinauer association.

depth of about 60 inches is grayish brown, mottled silty clay loam.

The Pawnee soils formed in glacial till on side slopes and narrow ridgetops. Typically, the surface layer is very dark brown clay loam or clay about 9 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, mottled, firm clay loam, and the lower part is dark grayish brown and grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is mixed light brownish gray and yellowish brown clay loam.

Minor in this association are Burchard, Kennebec, Kipson, Olmitz, and Steinauer soils. The well drained Burchard and Steinauer soils are on the lower side slopes. Kennebec soils are on flood plains and foot slopes along drainageways. The shallow Kipson soils are on the steeper side slopes. The loamy Olmitz soils are on foot slopes and alluvial fans.

This association is used mainly for cultivated crops, but some small areas are used for hay, pasture, or range. Corn, grain sorghum, soybeans, and wheat are the main cultivated crops. Erosion is a hazard. Controlling erosion and improving tilth and fertility are concerns in managing the major soils.

3. Kipson-Pawnee-Wymore association

Shallow or deep, gently sloping to moderately steep, somewhat excessively drained or moderately well drained soils that have a silty, loamy, or clayey subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by drainageways and creeks. It makes up about 4 percent of the county. It is about 35 percent Kipson soils, 25 percent Pawnee soils, 15 percent Wymore soils, and 25 percent minor soils (fig. 4).

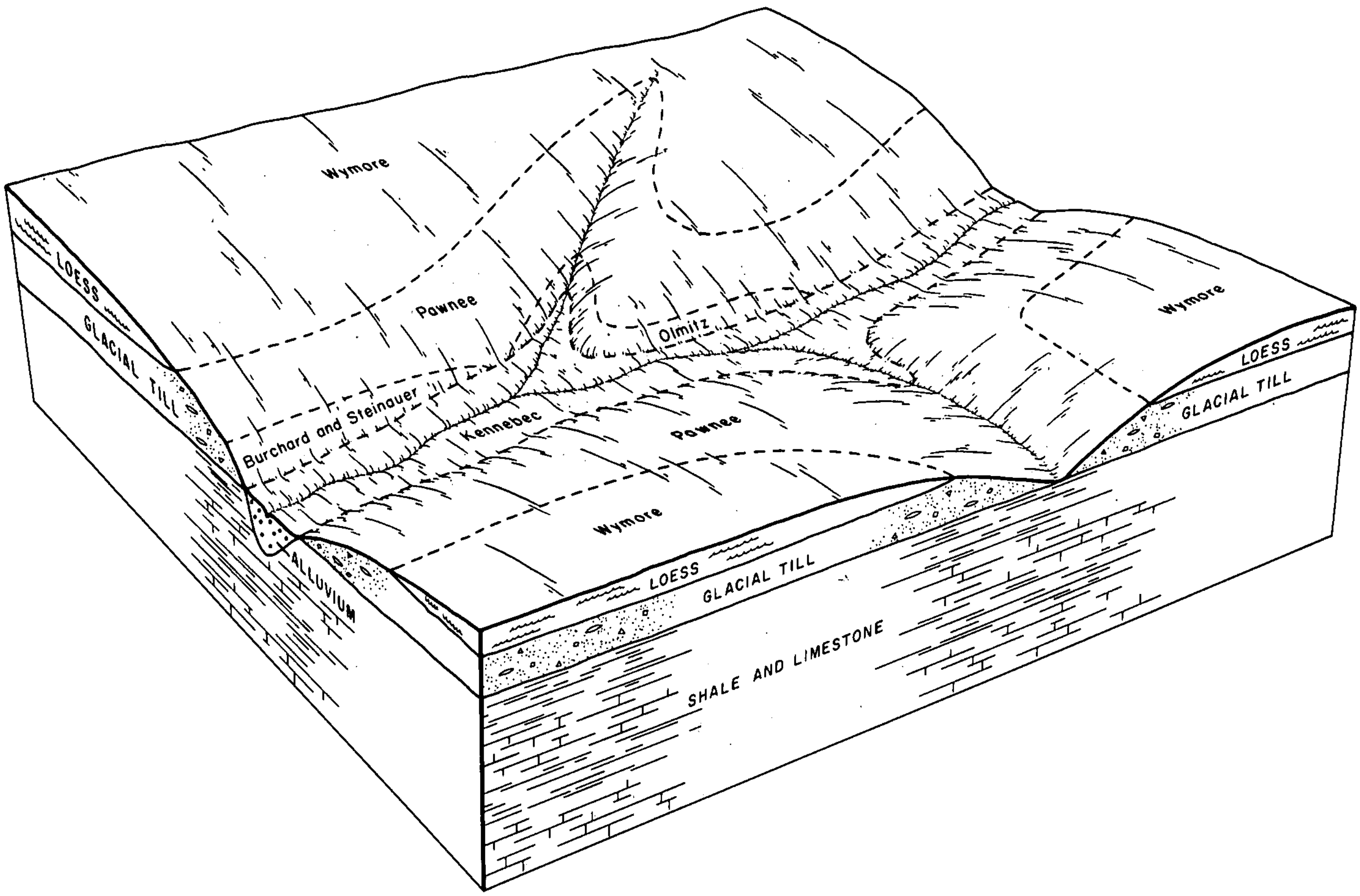

Figure 3.—Pattern of soils in the Wymore-Pawnee association.

The shallow, somewhat excessively drained Kipson soils formed in calcareous shale on narrow ridgetops and on side slopes. Typically, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The substratum is olive brown, calcareous shaly silty clay loam about 10 inches thick. Calcareous shale is at a depth of about 19 inches.

The deep, moderately well drained Pawnee soils formed in glacial till on narrow ridgetops and on side slopes. Typically, the surface layer is very dark brown clay loam or clay about 9 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, mottled, firm clay loam, and the lower part is dark grayish brown and grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is mixed light brownish gray and yellowish brown clay loam.

The deep, moderately well drained Wymore soils formed in loess on broad ridgetops and the upper side slopes. Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark brown and firm, the next part is very dark grayish brown and very firm, and the lower part is dark grayish brown, mottled, and firm. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Minor in this association are Benfield, Elmont, Kennebec, and Sibleyville soils. The moderately deep Benfield and Sibleyville soils are on narrow ridgetops and on side slopes. The well drained, silty Elmont soils are on the lower side slopes. Kennebec soils are on flood plains along drainageways.

About half of this association is used for cultivated crops and half for range, pasture, and hay. Grain sorghum and wheat are the main crops. Erosion is a hazard. Controlling erosion and improving tilth and fertility are concerns in managing the major soils for crops. Proper stocking rates, a uniform distribution of

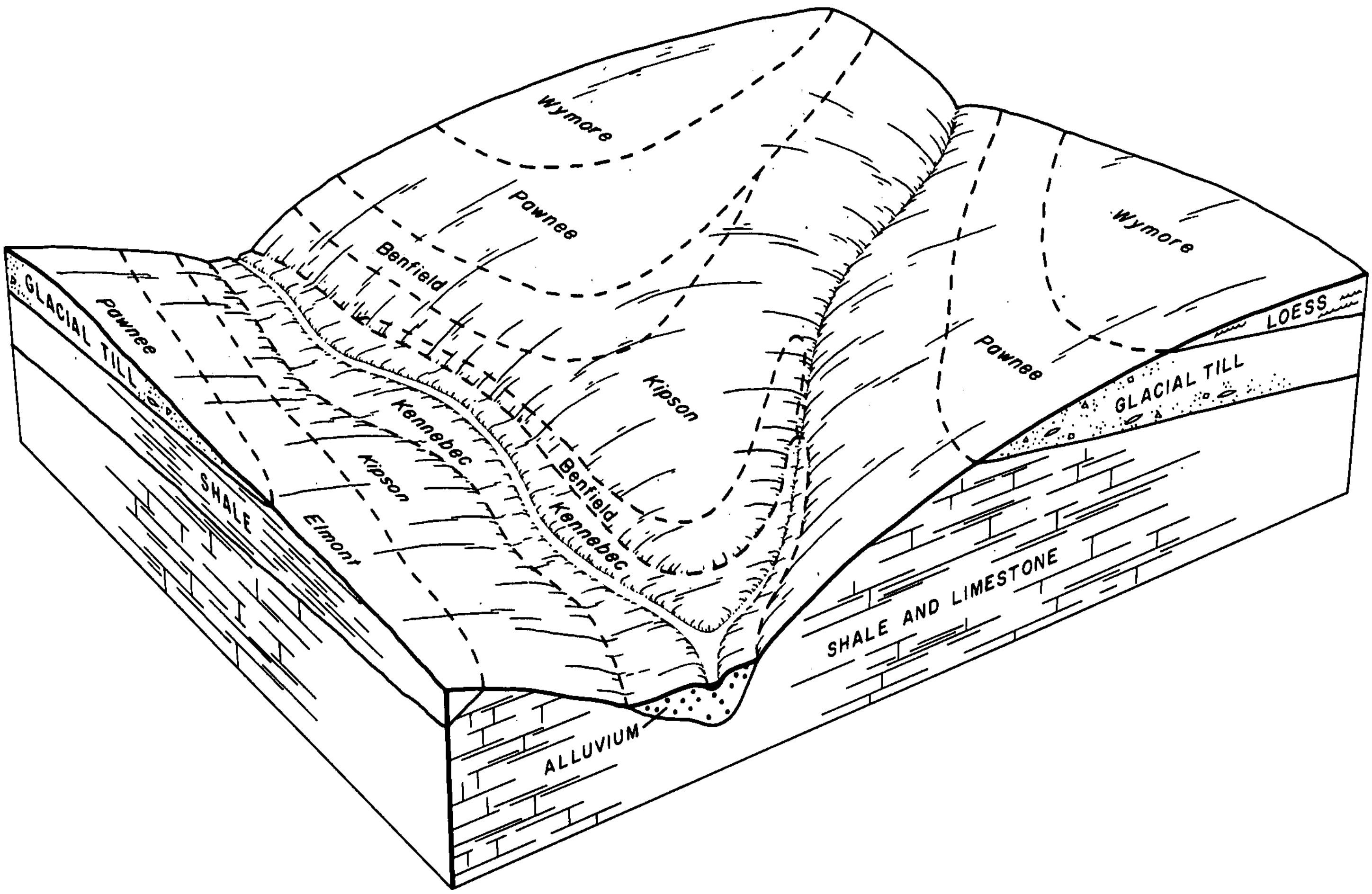

Figure 4.—Pattern of soils in the Kipson-Pawnee-Wymore association.

grazing, and timely deferment of grazing are needed in the areas used as range.

4. Kennebec-Wabash-Chase association

Deep, nearly level, moderately well drained, very poorly drained, or somewhat poorly drained soils that have a silty or clayey subsoil; on flood plains or terraces

This association is on flood plains or terraces along the major streams in the county. The soils are subject to flooding.

This association makes up about 3 percent of the county. It is about 40 percent Kennebec soils, 35 percent Wabash soils, 15 percent Chase soils, and 10 percent minor soils.

The moderately well drained Kennebec soils formed in silty alluvium on flood plains. Typically, the surface layer is black silt loam about 6 inches thick. The subsurface layer is black, friable silt loam about 24 inches thick. The next 11 inches is very dark brown, friable silt loam. The substratum to a depth of about 60 inches is very dark grayish brown clay loam.

The very poorly drained Wabash soils formed in clayey alluvium on flood plains. Typically, the surface layer is black silty clay loam about 12 inches thick. The subsurface layer is black, firm silty clay about 10 inches thick. The subsoil to a depth of about 60 inches is very dark gray and dark gray, very firm silty clay.

The somewhat poorly drained Chase soils formed in alluvium on terraces. Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. The subsurface layer is very dark brown and black, friable silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is black, very firm silty clay; the next part is very dark gray, mottled, very firm silty clay; and the lower part is dark grayish brown,

mottled, firm silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Minor in this association are Olmitz and Reading soils. The loamy Olmitz soils are on foot slopes and alluvial fans. The well drained Reading soils are on terraces.

This association is used mainly for cultivated crops, but some small areas are used for hay or timber. Corn, grain sorghum, soybeans, and wheat are the main crops. Surface drainage is a limitation in the very poorly drained areas. A drainage system, measures that control floodwater, and measures that improve tilth in the soils that have a clayey surface layer are the main management needs.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Pawnee clay loam, 1 to 4 percent slopes, is one of several phases in the Pawnee series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Burchard-Steinauer clay loams, 6 to 12 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations and capabilities for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Bf—Benfield silty clay loam, 5 to 9 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is very firm silty clay about 31 inches thick. The upper part is dark brown, and the lower part is brown. Clayey, calcareous shale is at a depth of about 37 inches. In places the depth to bedrock is more than 40 inches.

Included with this soil in mapping are small areas of Kipson soils and small areas where shale crops out. The shallow, somewhat excessively drained Kipson soils are on the lower side slopes. The areas where shale crops out are on the steeper side slopes. Included areas make up about 10 percent of the map unit.

Permeability is slow in the Benfield soil, and available water capacity is moderate. Runoff is medium. Natural fertility is high, and organic matter content is moderately low. The surface layer is slightly acid or neutral. The root zone is restricted by the shale at a depth of about 37 inches. The shrink-swell potential is high in the subsoil.

About half of the acreage is used for cultivated crops. The rest is used mainly as pasture or range. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help to control runoff and erosion. Leaving crop residue on the surface reduces the runoff rate, helps to control erosion, and increases the rate of water infiltration.

This soil is well suited to range. Overgrazing, however, results in a deterioration of the natural plant community and the invasion of weeds and the less productive grasses. Proper stocking rates, timely deferment of

grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the depth to bedrock are severe limitations. The slope and the depth to bedrock are severe limitations on sites for sewage lagoons. The deeper, less sloping adjacent soils on foot slopes are suitable sites for lagoons.

The capability subclass is IVe.

Bs—Burchard-Steinauer clay loams, 6 to 12 percent slopes. These moderately sloping and strongly sloping, well drained soils are on uplands. The Burchard soil is on narrow ridgetops and the less sloping side slopes (fig. 5). The Steinauer soil is on the steeper side slopes and in areas where erosion has removed most of the surface layer. Individual areas are irregular in shape and range from 15 to several hundred acres in size. They are about 63 percent Burchard soil and 27 percent Steinauer soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Burchard soil has a very dark grayish brown clay loam surface layer about 10 inches thick. The subsoil is firm clay loam about 27 inches thick. The upper part is dark yellowish brown, the next part is dark yellowish brown and yellowish brown, and the lower part is light brownish gray and mottled. The substratum to a depth of about 60 inches is light brownish gray, mottled clay loam. In some areas the depth to lime is more than 30 inches.

Typically, the Steinauer soil has a dark brown clay loam surface layer about 6 inches thick. The next 7 inches is olive brown, firm clay loam. The substratum to a depth of about 60 inches is mottled clay loam. It is pale brown in the upper part and grayish brown in the lower part.

Included with these soils in mapping are small areas of Kipson, Pawnee, and Wymore soils. Also included, on side slopes, are soils that have a sandy loam surface layer and subsoil. The shallow Kipson soils are along drainageways. The moderately well drained Pawnee and

Figure 5.—Typical area of Burchard-Steinauer clay loams, 6 to 12 percent slopes. The Burchard soil is in the darker areas.

Wymore soils are on the upper side slopes and on ridgetops. Included soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Burchard and Steinauer soils, and available water capacity is high. Runoff is rapid. Natural fertility is high in the Burchard soil and medium in the Steinauer soil. Organic matter content is moderately low in the Burchard soil and low in the Steinauer soil. Reaction is medium acid to neutral in the surface layer of the Burchard soil and moderately alkaline throughout the Steinauer soil. The shrink-swell potential is moderate throughout both soils.

Most of the acreage is used for cultivated crops. These soils are moderately well suited to wheat, grain sorghum, and alfalfa. Erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil improves fertility and increases the content of organic matter.

These soils are well suited to range. Overgrazing, however, destroys the protective plant cover and causes deterioration of the natural plant community. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential and the slope are moderate limitations if these soils are used as sites for dwellings. Properly designing and reinforcing foundations and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. The dwellings can be constructed in the less sloping areas. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome this limitation.

The moderately slow permeability is a severe limitation if these soils are used as septic tank absorption fields. Enlarging the field, however, helps to overcome the slow absorption of liquid waste. The slope is a severe limitation on sites for sewage lagoons. Less leveling and banking are needed during construction if the less sloping areas are selected as sites for the lagoons.

The capability subclass is IIIe.

Cc—Calco silty clay loam. This nearly level, very poorly drained soil is on flood plains. It is frequently flooded. Individual areas are long and narrow or irregularly shaped and range from 5 to more than 200 acres in size.

Typically, the surface soil is black silty clay loam about 17 inches thick. The substratum to a depth of about 60 inches is very dark gray, mottled silty clay loam that has thin strata of lighter colored material.

Included with this soil in mapping are small areas of the moderately well drained Kennebec soils and soils that have a sandy loam or loamy fine sand surface layer. Kennebec soils are in upstream areas or are adjacent to stream channels and on alluvial fans. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Calco soil, and available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is high, and organic matter content is moderate. The surface soil is moderately alkaline. The shrink-swell potential is moderate in the substratum.

Almost all of the acreage is pasture. This soil generally is unsuited to cultivated crops because of the excessive wetness. It is suited to reed canarygrass. Restricted grazing during periods when the water table is near the surface helps to prevent damage to the turf.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because of the flooding and the wetness.

The capability subclass is Vw.

Ch—Chase silty clay loam. This nearly level, somewhat poorly drained soil is on terraces along the larger streams and rivers. It is occasionally flooded. Individual areas are long and narrow and range from 10 to 70 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. The subsurface layer is very dark brown and black, friable silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is black, very firm silty clay; the next part is very dark gray, mottled, very firm silty clay; and the lower part is dark grayish brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained Kennebec soils. These soils are in the slightly higher, convex areas on the flood plains. They make up about 10 percent of the map unit.

Permeability is slow in the Chase soil, and available water capacity is high. Runoff is slow. A perched seasonal high water table is at a depth of 2 to 4 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is high in the subsoil.

Most of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, corn, soybeans, and alfalfa. Wetness and flooding sometimes delay spring planting. Field drainage ditches improve surface drainage. Returning crop residue to the soil or adding other organic material improves tilth.

This soil is well suited to range. Overgrazing, however, destroys the protective plant cover and causes deterioration of the natural plant community. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is well suited to trees, but only a small acreage remains native woodland. Equipment limitations

and seedling mortality are moderate. Harvesting equipment can be used during dry periods. Thinning and selective harvesting improve the stand. Tree seedlings and cuttings survive and grow well if competing plants are controlled.

Mainly because of the wetness and the flooding, this soil generally is unsuitable as a site for dwellings, septic tank absorption fields, and local roads and streets. It is suitable, however, as a site for sewage lagoons. Dikes, levees, or other flood control structures keep floodwater away from the lagoon.

The capability subclass is IIw.

Et—Elmont silt loam, 3 to 7 percent slopes. This moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface soil is very dark brown silt loam about 9 inches thick. The subsoil is firm silty clay loam about 28 inches thick. The upper part is dark brown, the next part is dark brown and mottled, and the lower part is yellowish brown and mottled. The substratum, to a depth of about 45 inches, is mixed yellowish brown and strong brown silty clay loam. Shale bedrock is at a depth of about 45 inches. In some areas the depth to bedrock is less than 40 inches.

Included with this soil in mapping are small areas of Pawnee and Vinland Variant soils. The moderately well drained Pawnee soils are on ridgetops. The moderately deep Vinland Variant soils are on side slopes. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Elmont soil, and available water capacity is moderate. Runoff is medium. Natural fertility is high, and organic matter content is moderate. The surface soil is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is moderate in the subsoil.

More than half of the acreage is used for cultivated crops. The rest is used mainly as pasture or range. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. Erosion is a hazard if cultivated crops are grown. It can be controlled, however, by terraces, grassed waterways, contour farming, and minimum tillage. Returning crop residue to the soil increases the content of organic matter.

This soil is well suited to range. Measures that prevent overgrazing and the invasion of undesirable grasses are needed. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling. Low strength and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material and installing a surface drainage system, however, help to prevent the road damage resulting from low strength and frost action.

The moderately slow permeability is a severe limitation if this soil is used as a septic tank absorption field. Enlarging the field, however, helps to overcome the slow absorption of liquid waste. The slope and the depth to bedrock are moderate limitations on sites for sewage lagoons. The less sloping, deeper included soils are suitable sites for lagoons.

The capability subclass is IIIe.

Ke—Kennebec silt loam. This nearly level, moderately well drained soil is on flood plains along creeks and rivers and on foot slopes. It is occasionally flooded for brief periods. Individual areas are long and narrow or irregularly shaped and range from 10 to 160 acres in size.

Typically, the surface layer is black silt loam about 6 inches thick. The subsurface layer is black, friable silt loam about 24 inches thick. The next 11 inches is very dark brown, friable silt loam. The substratum to a depth of about 60 inches is very dark grayish brown clay loam. In some areas both the lower part of the subsurface layer and the substratum are silty clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Chase soils on terraces. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Kennebec soil, and available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 3 to 5 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is well suited to grain sorghum, wheat, corn, soybeans, and pasture grasses. Spring flooding, however, delays planting or harvesting in some years. Returning crop residue to the soil increases the content of organic matter and improves tilth.

This soil is well suited to trees, but only a small acreage remains native woodland. Plant competition is moderate. Tree seedlings and cuttings survive and grow well only if competing plants are controlled. Harvesting mature trees, thinning, and planting desirable species keep the woodland in good condition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons, mainly because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Kn—Kennebec silt loam, channeled. This nearly level, moderately well drained soil is on flood plains and foot slopes. It is frequently flooded for brief periods. Individual areas are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is black silt loam about 6 inches thick. The subsurface layer is very dark brown, friable silt loam about 35 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown silt loam. In some areas lime is throughout the soil.

Included with this soil in mapping are small areas of Kipson and Pawnee soils on upland side slopes. Kipson soils are shallow. Pawnee soils have a dominantly clayey subsoil. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Kennebec soil, and available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 3 to 5 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. The shrink-swell potential is moderate.

Most areas are used for range or pasture. This soil generally is unsuited to cultivated crops because it is dissected by stream channels into small tracts that are not readily accessible and because it is frequently flooded. It is well suited, however, to grasses and legumes for pasture.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is suited to trees. Plant competition is moderate. Tree seedlings and cuttings survive and grow well only if competing plants are controlled. Thinning and selective harvesting improve the stand.

This soil generally is unsuitable as a site for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets, mainly because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is Vw.

Kp—Kipson silty clay loam, 5 to 25 percent slopes. This shallow, moderately sloping to moderately steep, somewhat excessively drained soil is on side slopes and ridgetops in the uplands. Individual areas are irregular in shape and range from 15 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The substratum is olive brown, calcareous shaly silty clay loam about 10 inches thick. Shale bedrock is at a depth of about 19 inches. In some areas the surface layer and substratum are cherty silty clay loam and are underlain by limestone.

Included with this soil in mapping are small areas of Benfield, Pawnee, and Steinauer soils and small areas where limestone crops out. The moderately deep Benfield soils are on ridgetops and side slopes. The deep Pawnee soils are on the upper side slopes and on narrow ridgetops. The deep, well drained Steinauer soils are on the steeper side slopes adjacent to streams. The areas where limestone crops out are on the steeper slopes. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Kipson soil, and available water capacity is low. Runoff is rapid. Natural fertility is medium, and organic matter content is moderate. The root zone is restricted by the shale at a depth of about 19 inches. The shrink-swell potential is moderate.

Almost all the acreage is range. This soil generally is unsuitable for cultivation because of the slope and a severe hazard of erosion. It is best suited to range. The major concerns in managing range are the hazard of erosion and the low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

The slope is a severe limitation if this soil is used as a site for dwellings, local roads and streets, septic tank absorption fields, or sewage lagoons. Also, the depth to bedrock is a severe limitation on sites for sanitary facilities and for dwellings with basements. The deeper, less sloping included soils are better suited to these uses. They generally are on the smoother parts of the landscape.

The capability subclass is VIe.

Mb—Morrill loam, 4 to 8 percent slopes. This moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is dark brown loam about 10 inches thick. The subsoil is firm clay loam about 31 inches thick. The upper part is dark reddish brown, and the lower part is yellowish red. The substratum to a depth of about 60 inches is brown sandy clay loam. In some areas the subsoil is sandy loam. In other areas it is calcareous in the lower part.

Included with this soil in mapping are small areas of the moderately well drained Pawnee soils on the upper side slopes and on ridgetops. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Morrill soil, and available water capacity is high. Runoff is medium. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is strongly acid to neutral. The shrink-swell potential is moderate in the subsoil.

About half the acreage is cultivated. The rest is mainly range. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help to control runoff and erosion. Leaving crop residue on the surface reduces the runoff rate, helps to control erosion, and increases the rate of water infiltration.

This soil is well suited to range. Overgrazing, however, retards the growth of the more productive grasses and results in the invasion of undesirable plants. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling. Low strength and frost action are moderate limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to prevent the road damage resulting from low strength and frost action.

The moderate permeability is a moderate limitation if this soil is used as a septic tank absorption field. Enlarging the field, however, helps to overcome the slow absorption of liquid waste. Slope and seepage are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. The less sloping included areas are suitable sites for lagoons.

The capability subclass is IIIe.

Me—Morrill clay loam, 4 to 8 percent slopes, eroded. This moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is dark reddish brown clay loam about 6 inches thick. The subsoil is firm clay loam about 28 inches thick. The upper part is dark reddish brown, and the lower part is yellowish red. The substratum to a depth of about 60 inches is brown sandy clay loam. In some areas the subsoil is sandy loam. In other areas it is calcareous in the lower part.

Included with this soil in mapping are small areas of the moderately well drained Pawnee soils on the upper side slopes and on ridgetops. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Morrill soil, and available water capacity is high. Runoff is medium. Natural fertility is medium, and organic matter content is moderately low. The surface layer is firm and cannot be easily tilled. It is strongly acid to neutral. The shrink-swell potential is moderate in the subsoil.

Most of the acreage is cultivated. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. Further erosion is a hazard if cultivated crops are grown. It can be controlled, however, by terraces, grassed waterways, contour farming, and minimum tillage. Leaving crop residue on the surface reduces the runoff rate and improves tilth.

This soil is well suited to range. Overgrazing, however, destroys the protective plant cover and results in deterioration of the natural plant community. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling. Low strength and frost action are moderate limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to prevent the road damage resulting from low strength and frost action.

The moderate permeability is a moderate limitation if this soil is used as a septic tank absorption field. Enlarging the field, however, helps to overcome the slow absorption of liquid waste. Slope and seepage are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. The less sloping included areas are suitable sites for lagoons.

The capability subclass is IIIe.

Om—Olmitz loam, 1 to 5 percent slopes. This gently sloping, moderately well drained soil is on foot slopes and alluvial fans. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsurface layer is about 26 inches of very dark brown, friable loam and clay loam. The subsoil to a depth of about 60 inches is very dark grayish brown, mottled, friable clay loam. In some areas the surface layer is dark grayish brown. In other areas it is silt loam. In a few areas the lower part of the subsoil contains lime.

Included with this soil in mapping are small areas of Chase, Pawnee, and Wymore soils. Pawnee and Wymore soils are on the upper side slopes. They have a clayey subsoil. The somewhat poorly drained Chase soils are on terraces. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Olmitz soil, and available water capacity is high. Runoff is medium. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is moderate throughout the soil.

Most of the acreage is cultivated. This soil is well suited to wheat, grain sorghum, corn, soybeans, and alfalfa. Erosion is a hazard, however, if cultivated crops are grown. Diversion terraces help to control erosion and the runoff from the higher adjacent side slopes. Leaving crop residue on the surface helps to maintain fertility and tilth.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material, however,

helps to prevent the road damage resulting from low strength.

The moderate permeability is a moderate limitation if this soil is used as a septic tank absorption field. Enlarging the field, however, helps to overcome the slow absorption of liquid waste. Slope and seepage are moderate limitations on sites for sewage lagoons. The less sloping areas are the better sites. Sealing the lagoon helps to control seepage.

The capability subclass is IIe.

Pa—Pawnee clay loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on side slopes and the narrow tops of ridges in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is very dark brown clay loam about 9 inches thick. The subsoil is about 40 inches thick. The upper part is very dark grayish brown, mottled, firm clay loam, and the lower part is dark grayish brown and grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is mixed light brownish gray and yellowish brown clay loam. In some areas the soil is redder.

Included with this soil in mapping are small areas of the well drained Burchard and Morrill soils on the lower side slopes. These soils make up about 10 percent of the map unit.

Permeability is slow in the Pawnee soil, and available water capacity is moderate. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is high in the subsoil.

Most of the acreage is cultivated. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. Erosion is a hazard, however, if cultivated crops are grown. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss. Leaving crop residue on the surface increases the rate of water infiltration, reduces the runoff rate, and helps to prevent surface crusting.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. The shrink-swell potential, low strength, and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations. Drainage ditches along the roads reduce the wetness and thus help to prevent the damage caused by frost action.

Because of the slow permeability and the wetness, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIe.

Pb—Pawnee clay loam, 4 to 8 percent slopes. This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is very dark brown clay loam about 9 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, mottled, firm clay loam, and the lower part is dark grayish brown and grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is mixed light brownish gray and yellowish brown clay loam. In some areas the soil is redder. In other areas the surface layer is clay.

Included with this soil in mapping are small areas of the well drained Burchard and Morrill soils on the lower side slopes. These soils make up about 10 percent of the map unit.

Permeability is slow in the Pawnee soil, and available water capacity is moderate. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is high in the subsoil.

Most of the acreage is cultivated. This soil is moderately well suited to wheat, grain sorghum, soybeans, and alfalfa. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, grassed waterways, contour farming, and minimum tillage. Leaving crop residue on the surface reduces the runoff rate, helps to control erosion, and increases the rate of water infiltration.

This soil is well suited to range. Overgrazing, however, results in a deterioration of the natural plant community and the invasion of weeds. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. The shrink-swell potential, low strength, and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations. Drainage ditches along the roads reduce the wetness and thus help to prevent the damage caused by frost action.

Because the slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. The slope is a moderate limitation on sites for sewage lagoons. The less sloping adjacent soils are better sites.

The capability subclass is IIIe.

Pe—Pawnee clay, 4 to 8 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown clay about 6 inches thick. The subsoil is mottled, very firm clay about 34 inches thick. The upper part is very dark grayish brown, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, coarsely mottled clay loam. In some areas the soil is redder.

Included with this soil in mapping are small areas of Burchard and Kipson soils on the lower side slopes. Kipson soils are shallow. Burchard soils are well drained. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Pawnee soil, and available water capacity is high. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is medium, and organic matter content is moderate. Tilth is poor. The surface layer and the upper part of the subsoil are medium acid to neutral. The shrink-swell potential is high in the subsoil.

Most of the acreage is cultivated. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. If cultivated crops are grown, further erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help to control erosion and runoff. Leaving crop residue on the surface improves tilth and increases the rate of water infiltration.

This soil is well suited to range. The major concerns in managing range are erosion and low forage production on abandoned cropland. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. The shrink-swell potential, low strength, and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations. Drainage ditches along the roads reduce the wetness and thus help to prevent the damage caused by frost action.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping adjacent soils are better sites.

The capability subclass is IIIe.

Pt—Pits, quarries. These are excavated areas from which soil and limestone have been removed. Gravel and sand have been removed from a few areas. The areas are irregular in shape.

Typically, the bottom of the pit is level, impervious bedrock. It is surrounded by vertical walls. Pits without drainage outlets are filled with water.

These pits are unsuitable for cultivation, range, or woodland. Most areas are bare of vegetation. Some abandoned pits can be developed so that they are suitable as habitat for wildlife.

This map unit is not assigned a capability class or subclass.

Re—Reading silt loam. This nearly level, well drained soil is on terraces. It is subject to rare flooding. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is very dark brown, friable silt loam about 10 inches thick. The subsoil is silty clay loam about 44 inches thick. The upper part is very dark brown and friable, the next part is dark brown and firm, and the lower part is brown, mottled, and firm. In some areas the subsoil is silt loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Chase soils on terraces. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Reading soil, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The shrink-swell potential is moderate in the subsoil.

Most of the acreage is cultivated. This soil is well suited to wheat, grain sorghum, soybeans, corn, and alfalfa. Minimizing tillage and returning crop residue to the soil improve tilth and increase the content of organic matter.

This soil is suited to trees, but only a small acreage remains native woodland. Plant competition is moderate. Tree seedlings and cuttings survive and grow well only if competing plants are controlled. Thinning and selective harvesting improve the stand.

The flooding is a severe hazard if this soil is used as a site for dwellings. Overcoming this hazard is difficult without major flood control measures. Low strength and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations.

The moderate permeability is a moderate limitation if this soil is used as a septic tank absorption field. Enlarging the field, however, helps to overcome the slow absorption of liquid waste. Seepage is a moderate limitation on sites for sewage lagoons. It can be controlled, however, by sealing the lagoon.

The capability class is I.

Sb—Sibleyville loam, 4 to 8 percent slopes. This moderately deep, moderately sloping, well drained soil is

on convex side slopes and the narrow tops of ridges in the uplands. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is dark brown and brown, friable loam about 14 inches thick. The substratum, to a depth of about 37 inches, is yellowish red channery loam. Shale bedrock is at a depth of about 37 inches. In some areas the depth to bedrock is less than 20 inches, and in other areas it is more than 40 inches.

Included with this soil in mapping are small areas of the deep Morrill and Pawnee soils on the upper side slopes and on ridgetops. These soils make up about 10 percent of the map unit.

Permeability and available water capacity are moderate in the Sibleyville soil. Runoff is medium. Natural fertility also is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid to neutral. The root zone is restricted by the shale at a depth of about 37 inches.

About half of the acreage is cultivated. The rest is used mainly as range or pasture. This soil is moderately well suited to grain sorghum, soybeans, wheat, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and reduces the runoff rate.

This soil is suited to range. The major concerns of management are erosion and the moderate available water capacity. Overgrazing reduces the vigor and retards the growth of the grasses. An adequate plant cover reduces the runoff rate, helps to prevent excessive soil loss, and increases the moisture supply. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition.

This soil is suitable for trees, but only a small acreage remains native woodland. Tree seedlings and cuttings survive and grow well if competing plants are controlled. Thinning and selective harvesting improve the stand.

This soil is well suited to dwellings without basements. The depth to bedrock is a moderate limitation, however, on sites for dwellings with basements. The deeper included soils are better sites. Frost action is a moderate limitation on sites for local roads and streets. It can be overcome, however, by replacing the base material.

The depth to bedrock is a severe limitation if this soil is used as a site for septic tank absorption fields or sewage lagoons. The deeper, less sloping included or adjacent soils are suitable sites for lagoons.

The capability subclass is IVe.

St—Steinauer clay loam, 12 to 25 percent slopes. This strongly sloping and moderately steep, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is dark brown clay loam about 6 inches thick. The next 7 inches is olive brown, firm clay loam. The substratum to a depth of about 60 inches is mottled clay loam. It is pale brown in the upper part and grayish brown in the lower part. In some areas the soil has a surface layer and subsoil of sandy loam. In other areas the depth to lime is more than 14 inches.

Included with this soil in mapping are small areas of Pawnee soils and small areas where shale or limestone crops out. The moderately well drained Pawnee soils are on the upper side slopes and on narrow ridgetops. The areas where shale or limestone crops out are on steep side slopes. Included areas make up about 10 percent of the map unit.

Permeability is moderately slow in the Steinauer soil, and available water capacity is high. Runoff is rapid. Natural fertility is medium, and organic matter content is low. The surface layer is mildly alkaline or moderately alkaline. The shrink-swell potential is moderate throughout the soil.

Most of the acreage is range. Because of the hazard of erosion and the slope, this soil generally is unsuitable for cultivated crops. It is best suited to range. The major management concern is the hazard of erosion. A protective plant cover and ground mulch help to prevent excessive soil loss and reduce the runoff rate. Overgrazing reduces the extent of the plant cover and causes excessive runoff. Measures that control brush, proper stocking rates, and timely deferment of grazing help to keep the range in good condition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons, mainly because of the slope. The less sloping adjacent soils are better sites.

The capability subclass is VIe.

Vv—Vinland Variant loam, 5 to 25 percent slopes. This moderately deep, moderately sloping to moderately steep, somewhat excessively drained soil is on upland side slopes cut by some incised drainageways. Individual areas generally are long and narrow and range from 5 to 200 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown, friable loam about 16 inches thick. The substratum is brown loam about 5 inches thick. Sandy and silty shale bedrock is at a depth of about 29 inches. In some areas the subsoil has rock fragments.

Included with this soil in mapping are small areas of the deep Elmont and Pawnee soils. Elmont soils are on foot slopes. Pawnee soils are on the upper side slopes and on ridgetops. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Vinland Variant soil, and available water capacity is low. Runoff is rapid. Natural fertility is medium, and organic matter content is moderately low. The root zone is restricted by the shale at a depth of about 29 inches.

Nearly all of the acreage is woodland. It is used for grazing, however, because most adjacent areas are used as range or pasture. The major concerns in managing range are the hazard of erosion, the low available water capacity, and competing trees. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, timely deferment of grazing, and measures that thin out the canopy and control brush help to keep the range in good condition.

This soil is suited to trees. Tree seedlings and cuttings survive and grow well if competing plants are controlled. Because of the slope, however, the use of logging equipment is restricted and erosion is a hazard along logging roads and skid trails. Thinning and selective harvesting improve the stand.

The slope is a severe limitation if this soil is used as a site for dwellings or local roads and streets. The soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to bedrock and the slope are severe limitations. The deeper, less sloping included soils on foot slopes are suitable sites for these uses.

The capability subclass is VIe.

Wa—Wabash silty clay loam. This nearly level, very poorly drained soil is in low areas on flood plains (fig. 6). It is occasionally flooded. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is black silty clay loam about 12 inches thick. The subsurface layer is black, firm silty clay about 10 inches thick. The subsoil to a depth of about 60 inches is very dark gray and dark gray, very firm silty clay. In some areas it is silty clay loam.

Included with this soil in mapping are small areas of Kennebec and Reading soils. The moderately well drained Kennebec soils are on flood plains adjacent to stream channels. The well drained Reading soils are on terraces. Included soils make up about 10 percent of the map unit.

Permeability is very slow in the Wabash soil, and available water capacity is moderate. Runoff is very slow. A seasonal high water table is within a depth of 1 foot. Natural fertility is high, and organic matter content

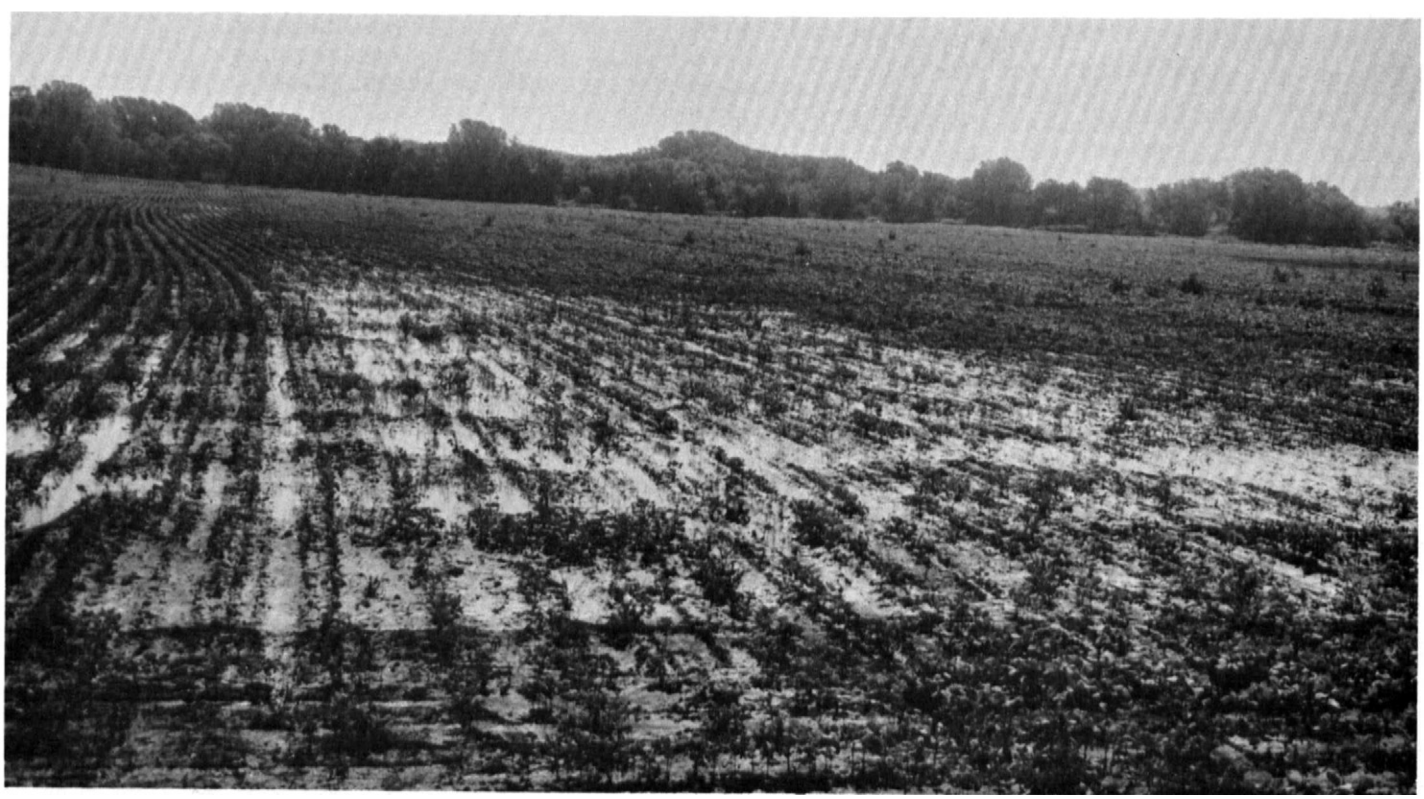

Figure 6.—Ponded water on Wabash silty clay loam. This soil is very slowly permeable and very poorly drained.

is moderate. The surface layer is medium acid to neutral. The shrink-swell potential is very high in the subsoil.

Most of the acreage is cultivated. This soil is moderately well suited to wheat, grain sorghum, corn, soybeans, and alfalfa. Flooding or ponding often delays spring planting. Also, the soil is droughty in the summer because the clayey subsoil absorbs and releases moisture slowly. Field drainage ditches help to remove excess surface water. Returning crop residue to the soil or adding other organic material improves tilth and increases the rate of water infiltration.

This soil is suited to trees, but only a small acreage remains native woodland. Because of the wetness, equipment limitations and plant competition are severe and seedling mortality is moderate. The trees should be harvested in fall and winter, when the amount of precipitation is lower. Tree seedlings and cuttings survive and grow well only if competing plants are controlled. Also, site preparation and controlled burning, spraying, or cutting are needed.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons, mainly because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIIw.

Wb—Wymore silty clay loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on broad upland ridgetops. Individual areas are irregular in shape and range from 10 to several thousand acres in size.

Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark brown and firm, the next part is very dark grayish brown and very firm, and the lower part is dark grayish brown, mottled, and firm. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In some areas the subsoil is clay.

Permeability is slow, and available water capacity is high. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid or slightly acid. The shrink-swell potential is high in the subsoil.

Most of the acreage is cultivated. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa (fig. 7). If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by terraces, grassed waterways, contour farming, and minimum tillage. Returning crop residue to the soil helps to maintain a high level of fertility and increases the rate of water infiltration.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations. Drainage ditches along the roads reduce the wetness and thus help to prevent the damage caused by frost action.

This soil is suitable as a site for sewage lagoons. It generally is unsuitable, however, as a site for septic tank absorption fields because of the slow permeability and the wetness.

The capability subclass is IIe.

Wc—Wymore silty clay loam, 4 to 8 percent slopes. This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 60 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is silty clay about 32 inches thick. The upper part is very dark brown and firm, the next part is very dark grayish brown and very firm, and the lower part is dark grayish brown, mottled, and firm. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In some areas the surface layer is silty clay.

Included with this soil in mapping are small areas of the well drained Burchard soils on the lower side slopes. These soils make up about 15 percent of the map unit.

Permeability is slow in the Wymore soil, and available water capacity is high. Runoff is medium. A perched seasonal high water table is at a depth of 1 to 3 feet. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled. It is medium acid or slightly acid. The shrink-swell potential is high in the subsoil.

Most of the acreage is cultivated. This soil is moderately well suited to wheat, grain sorghum, soybeans, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help to control runoff and erosion. Leaving crop residue on the surface reduces the runoff rate, increases the rate of water infiltration, and improves tilth.

This soil is well suited to range. Overgrazing, however, destroys the protective plant cover and causes deterioration of the natural plant community. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material, however, help to prevent the structural damage caused by shrinking and swelling and by wetness. Low strength

Figure 7.—A cultivated area of Wymore silty clay loam, 1 to 4 percent slopes, which is prime farmland.

and frost action are severe limitations on sites for local roads and streets. Strengthening or replacing the base material, however, helps to overcome these limitations. Drainage ditches along the roads reduce the wetness and thus help to prevent the damage caused by frost action.

This soil generally is unsuitable as a septic tank absorption field because of the slow permeability and the wetness. The slope is a moderate limitation on sites for sewage lagoons. The less sloping adjacent soils are better sites.

The capability subclass is IIIe.

prime farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, range, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber or is available for those uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the

criteria for prime farmland is available at local offices of the Soil Conservation Service.

About 215,000 acres in Nemaha County, or 47 percent of the total acreage, meets the requirements for prime farmland. This land occurs as scattered areas throughout the county but is mainly in the northern part. About 200,000 acres of the prime farmland is used for crops. The crops grown on this land, mainly sorghum, corn, soybeans, and wheat, account for an estimated 50 percent of the local farm income each year.

The map units in Nemaha County that are considered prime farmland are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil map at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed soil map units."

The Wabash soil on the following list is considered prime farmland only in areas where it is adequately drained. Onsite evaluation is needed to determine whether or not a specific area of this soil is prime farmland.

The map units that meet the requirement for prime farmland are:

Ch—Chase silty clay loam
Et—Elmont silt loam, 3 to 7 percent slopes
Ke—Kennebec silt loam
Mb—Morrill loam, 4 to 8 percent slopes
Om—Olmitz loam, 1 to 5 percent slopes
Pa—Pawnee clay loam, 1 to 4 percent slopes
Re—Reading silt loam
Sb—Sibleyville loam, 4 to 8 percent slopes
Wa—Wabash silty clay loam (where drained)
Wb—Wymore silty clay loam, 1 to 4 percent slopes
Wc—Wymore silty clay loam, 4 to 8 percent slopes

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, and trees.

crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

crops

About 71 percent of the acreage in Nemaha County was used for cultivated crops during the period 1967 to 1977. This compares with 67 percent during the previous 10-year period (*3*). Sorghum was grown on about 42 percent of the acreage used for cultivated crops, wheat on 17 percent, corn on 16 percent, alfalfa on 6 percent, and minor crops, such as hay (fig. 8), soybeans, and oats, on 19 percent. The acreage planted to sorghum and soybeans increased over the previous 10-year period. The acreage of all other crops remained the same or decreased.

The main management needs in cultivated areas of the county are measures that help to control erosion and improve fertility and tilth.

Erosion is the major hazard on about 90 percent of the cropland in Nemaha County. It reduces the productivity of the soils. If the surface layer is lost through erosion, most of the available plant nutrients and organic matter, which has positive effects on structure, water infiltration, available water capacity, and tilth, are also lost. Measures that control erosion are especially needed on soils that have a loamy surface layer and a clayey subsoil, such as Wymore and Pawnee soils. Preparing a good seedbed and tilling are difficult in the clayey spots that remain after the original friable surface layer has eroded away. Such spots are common in areas of Pawnee soils.

In many areas erosion results in the pollution of streams by sediment, nutrients, and pesticides. Controlling erosion helps to prevent this pollution and thus improves the quality of water.

Minimum tillage, terraces, diversions, contour farming, and a cropping system that includes close-growing crops as well as row crops help to control erosion, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods helps to control erosion and

Figure 8.—Baled hay on Pawnee clay loam, 4 to 8 percent slopes.

preserves the productive capacity of the soils. Minimum tillage in the areas used for sorghum and other row crops is effective in controlling erosion on the more sloping soils and can be used on most of the soils in the survey area.

Terraces and diversions reduce the length of slopes and thus the runoff rate and the risk of erosion. They are most practical on deep, well drained soils that have uniform, regular slopes.

The crops on most of the arable soils in the county respond well to applications of nitrate and phosphate fertilizer. On all soils the amount of lime and fertilizer used should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extension Service can help to determine the kinds and amounts needed.

Organic matter provides nitrogen to crops. It also increases the rate of water intake, helps to prevent surface crusting, helps to control erosion, and improves tilth. Most of the soils in the survey area that are used for crops have a surface layer of clay loam or silty clay loam. Intensive rainfall causes surface crusting. The crusted surface is hard when dry and is nearly impervious to water. Because of the hard surface, the runoff rate increases. Regular additions of organic material improve soil structure and help to prevent crusting. Leaving crop residue on the surface also helps to prevent crusting.

Information about the erosion control measures, drainage systems, and crops suitable for each kind of soil can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

pasture

About 10 percent of Nemaha County is used for cool-season tame grasses, such as smooth brome, tall fescue, reed canarygrass, and orchardgrass. The areas used for tame grasses are throughout the county. Some support only tame grasses, and others support tame and native grasses (fig. 9).

The main management needs in the areas used for tame grasses are measures that maintain or improve the quality or quantity of forage, help to control erosion, and reduce water loss. Measures that promote leaf development, root growth, flower-stalk formation, seed production, forage regrowth, and food storage in roots are essential if maximum forage yields are to be maintained.

Proper stocking rates help to keep the pasture in good condition. The number of livestock should be adjusted to the expected level of yields. Adjusting the number of livestock allows the pasture to provide forage for the entire grazing season. Generally, about 40 pounds of forage per mature cow per day is needed for continuous seasonal grazing and 35 pounds for rotation grazing.

Delaying grazing in the spring until the soil is dry and firm helps to prevent trampling and surface compaction. Deferred grazing during the midsummer dormancy of the grasses helps to maintain or improve the quality and quantity of forage. Rotation grazing helps to prevent depletion of the pasture by allowing the grasses to recover after they have been grazed. Providing water and salt at a variety of locations results in a uniform distribution of grazing.

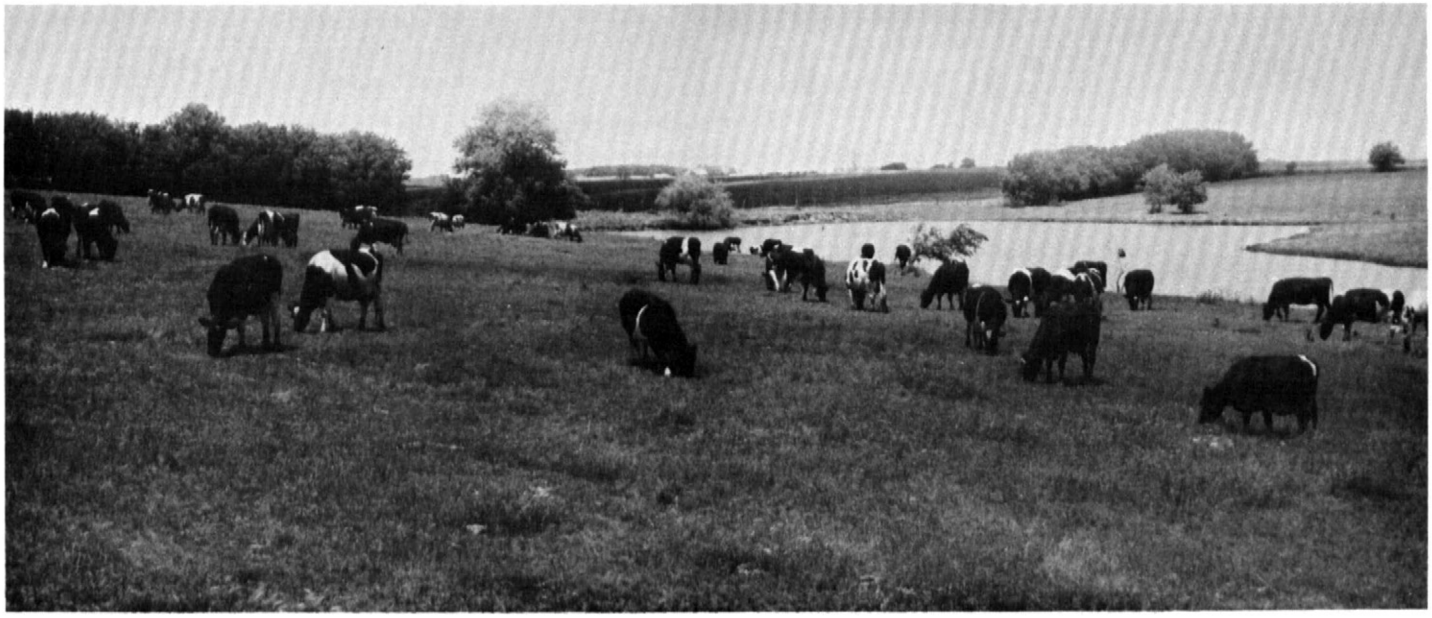

Figure 9.—Dairy cattle grazing in an area of Wymore silty clay loam, 1 to 4 percent slopes, used for tame grass pasture.

Applying fertilizer helps to keep the pasture in good condition. The kind and amount should be based on the results of soil tests and on field observations.

Mowing a pasture that has been grazed unevenly or that has an excess of forage and spraying with herbicides help to control invading trees, brush, low quality grasses, and broadleaf weeds.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The

numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Kenneth L. Hladek, range conservationist, Soil Conservation Service, helped prepare this section.

About 41,265 acres in Nemaha County, or 9 percent of the total acreage, is rangeland. Most of the livestock is raised on small, cow-calf stock farm units, especially in the northern two-thirds of the county, where small acreages of rangeland are interspersed among larger fields of crops. A few ranches are in the southern third of the county, where the tracts of rangeland tend to be larger.

Most of the livestock obtain a large part of their forage from tame grass pastures, principally of smooth brome. This grass plays a dominant role in the large local dairy industry. It is more extensive than the native grasses. Some farmers or ranchers supplement the grassland forage with grain sorghum crop residue and occasionally with small grain winter pasture. In winter rangeland forage is supplemented by hay and protein concentrates.

Soils strongly influence the potential natural plant community on specific tracts of rangeland in the county. The soils and climate generally are suitable for a community of tall prairie grasses dominated by bluestems, indiangrass, and switchgrass.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for many soils in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be

used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

On much of the rangeland in Nemaha County, forage production has been drastically reduced by excessive continuous grazing and the invasion of woody species. On more than 32,000 acres treatment is needed. On 16,000 of these acres brush control is needed, and on 5,000 acres the native grasses should be reestablished. Proper stocking rates and a good distribution of grazing help to keep the range in good condition. A planned grazing system, deferred grazing, reseeding, and brush and weed control improve the range.

woodland management and productivity

Prepared by Keith A. Ticknor, forester, Soil Conservation Service.

About 11,350 acres in Nemaha County, or 2.5 percent of the total acreage, is forested. The woodland occurs as scattered small, irregular tracts along streams, on steep uplands, and in upland drainageways.

Many of the trees in the county, especially black walnut, eastern cottonwood, green ash, oak, and hickory, can be used for wood products. Many of the soils have good potential for the trees used in the production of sawtimber, firewood, Christmas trees, and other wood products. Most of these soils, however, are used as cropland and are unlikely to be used for trees.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitations* reflect the characteristcs and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees

are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Prepared by Keith A. Ticknor, forester, Soil Conservation Service.

Trees are on most farmsteads in Nemaha County. They either were present when the farmsteads were established or have been planted at various times by the landowners. Siberian elm makes up a high percentage of the trees in the older windbreaks. Other common trees and shrubs are green ash, common hackberry, boxelder, black walnut, Austrian pine, eastern redcedar, lilac, and multiflora rose.

Tree planting on farmsteads is a continual need because old trees deteriorate after they pass maturity, because some trees die as a result of storms, diseases, or insects, and because new windbreaks are needed in areas where farming is expanding. Windbreaks are especially important on the numerous dairy farms in the county.

Trees and shrubs can be easily established on most of the soils in the county. In order for windbreaks to fulfill their intended purpose, however, the species selected for planting should be those suited to the soils on the site. Permeability, available water capacity, and fertility greatly affect the growth rate. Selecting suitable species helps to ensure survival and a maximum growth rate. Other management needs are proper site preparation prior to planting and control of weeds and other competing plants after the windbreak is established.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, keep snow from blowing off the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Nemaha County has several areas of scenic, geologic, and historic interest. Fort Markley, which is near Seneca, is a replica of the frontier fort. It has a museum devoted to prehistoric life and to the American Indian. The numerous watershed lakes, farm ponds, and streams provide opportunities for water sports. Nemaha State Fishing Lake, near the center of the county, provides opportunities for fishing, picnicking, boating, and camping. The potential for additional development for recreation uses is good throughout the county.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to

heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Nemaha County are bobwhite quail, mourning dove, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl. Nongame species are numerous because of the diverse habitat types in the county. Cropland, woodland, and pasture are interspersed throughout the county. Each of these habitat types provides a habitat for a particular group of species.

Furbearers are common along many of the streams. They are trapped on a limited basis.

Nemaha State Fishing Lake, watershed lakes, stock water ponds, and streams provide good to excellent fishing. The species commonly caught are bass, channel cat, flathead catfish, carp, and bluegill.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, wheat, oats, barley, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, indiangrass, goldenrod, ragweed, native legumes, wheatgrass, and gramagrass.

Shrubs are bushy woody plants that produce fruit, seeds, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwing blackbirds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, coyote, meadowlark, and killdeer.

Technical assistance in planning wildlife areas and in determining vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from local offices of the Kansas Fish and Game Commission and the Cooperative Extension Service.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning,

design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

sanitary facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function

unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to

12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and

depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 18.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 18.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table

that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 18 shows laboratory test data for pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 66 (AASHTO); Unified classification—D 2487 66T (ASTM); Mechanical analysis—T 88 72 (AASHTO); Liquid limit—T 89 89 (AASHTO); Plasticity index—T 90 70 (AASHTO); and Moisture density, Method A—T 99 74 (AASHTO).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 19, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*4*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*5*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Benfield series

The Benfield series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in residuum of calcareous, clayey shale. Slope ranges from 5 to 9 percent.

Benfield soils are similar to Pawnee and Wymore soils and commonly are adjacent to those soils and to Kipson soils. The deep Pawnee and Wymore soils are on the upper side slopes and on ridgetops. Kipson soils are less than 20 inches deep over bedrock. They are on side slopes and narrow ridgetops.

Typical pedon of Benfield silty clay loam, 5 to 9 percent slopes, 2,500 feet east and 200 feet south of the northwest corner of sec. 8, T. 1 S., R. 14 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, firm; common fine roots; slightly acid; clear smooth boundary.

B21t—6 to 19 inches; dark brown (7.5YR 3/2) silty clay, brown (7.5YR 4/2) dry; moderate fine and medium blocky structure; extremely hard, very firm; common fine roots; neutral; gradual smooth boundary.

B22t—19 to 37 inches; brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; weak medium blocky structure; extremely hard, very firm; few fine roots; few lime concretions; moderately alkaline; clear wavy boundary.

Cr—37 inches; calcareous clayey shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. The mollic epipedon ranges from 9 to 20 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is dominantly silty clay loam but is cherty silty clay loam in some pedons. It is neutral or slightly acid. The B2t horizon has hue of 7.5YR or 5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 6. It is silty clay, cherty silty clay, or silty clay loam.

Burchard series

The Burchard series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in calcareous glacial till. Slope ranges from 6 to 12 percent.

Burchard soils are similar to Morrill, Olmitz, and Steinauer soils and commonly are adjacent to those soils and to Kennebec and Pawnee soils. Morrill soils are on ridgetops or the upper side slopes. Their subsoil is redder than that of the Burchard soils. Olmitz soils do not have an argillic horizon and have a mollic epipedon that is thicker than that of the Burchard soils. They are on foot slopes and alluvial fans. Steinauer soils have lime near the surface and do not have an argillic horizon. They are on the steeper side slopes. Kennebec soils do not have an argillic horizon. They are on flood plains and foot slopes. Pawnee soils have a clayey subsoil. They are on ridgetops or the upper side slopes.

Typical pedon of Burchard clay loam, in an area of Burchard-Steinauer clay loams, 6 to 12 percent slopes, 300 feet north and 100 feet west of the southeast corner of sec. 28, T. 4 S., R. 13 E.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; common fine roots; a few pebbles; medium acid; clear smooth boundary.

B21t—10 to 17 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; hard, firm; common fine roots; a few pebbles; slightly acid; gradual wavy boundary.

B22t—17 to 22 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) clay loam, yellowish brown (10YR 5/6) and pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; hard, firm; few fine roots; a few pebbles; neutral; gradual wavy boundary.

B3—22 to 37 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; hard, firm; few fine roots; a few pebbles; common small and medium seams and pockets of soft white lime; strong effervescence; moderately alkaline; diffuse wavy boundary.

C—37 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; many medium and coarse distinct yellowish brown (10YR 5/6) mottles; weak medium and coarse blocky structure; hard, firm; few fine roots; a few pebbles; few fine dark brown concretions; common fine and medium seams and pockets of soft white lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 50 inches. The mollic epipedon ranges from 8 to 18 inches in thickness. The depth to lime ranges from 13 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It ranges from medium acid to neutral. The B2t horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 or 6 dry), and chroma of 3 to 6. It ranges from slightly acid to moderately alkaline. The lower part of this horizon is more grayish than the upper part and in some pedons has seams and pockets of soft white lime. The C horizon has hue of 10YR or 2.5Y, value of 6 or 7, and chroma of 2. It is mildly alkaline or moderately alkaline.

Calco series

The Calco series consists of deep, very poorly drained, moderately permeable soils on flood plains. These soils formed in calcareous alluvium. Slope is 0 to 1 percent.

These soils are taxadjuncts to the Calco series because they are finely stratified at a depth of 10 to 20 inches. This difference, however, does not alter the use or behavior of the soils.

Calco soils commonly are adjacent to Burchard, Kennebec, Pawnee, and Steinauer soils. Burchard, Pawnee, and Steinauer soils are better drained than the Calco soils and are on uplands. Kennebec soils also are better drained and are on flood plains. They do not have lime in the solum.

Typical pedon of Calco silty clay loam, 800 feet west and 100 feet north of the southeast corner of sec. 25, T. 3 S., R. 12 E.

A1—0 to 17 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; few fine prominent dark reddish brown (5YR 3/3) mottles; weak fine subangular blocky structure; slightly hard, friable; many fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C1g—17 to 22 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few thin lighter colored strata; few fine prominent dark reddish brown (5YR 3/3) mottles; weak fine subangular blocky structure; slightly hard, friable; common fine roots; strong effervescence; moderately alkaline; diffuse smooth boundary.

C2g—22 to 45 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few thin lighter colored strata; few fine prominent dark reddish brown (5YR 3/3) and few fine faint grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; hard, firm; few fine roots; slight effervescence; moderately alkaline; diffuse smooth boundary.

C3g—45 to 60 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few thin lighter colored strata; common fine prominent dark reddish brown (5YR 3/3) mottles; massive; hard, firm; few fine roots; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The soils typically are moderately alkaline and contain lime throughout, but a few pedons do not contain lime and are neutral or mildly alkaline below a depth of 24 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is dominantly silty clay loam, but the range includes silt loam. The Cg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 0 to 2. It is silty clay loam, silt loam, loam, or clay loam.

Chase series

The Chase series consists of deep, somewhat poorly drained, slowly permeable soils on terraces along the larger streams. These soils formed in alluvium. Slope is 0 to 1 percent.

Chase soils are similar to Wabash soils and commonly are adjacent to Kennebec, Reading, and Wabash soils. The very poorly drained Wabash soils are lower on the landscape than the Chase soils. The subsoil of Kennebec and Reading soils is less clayey than that of the Chase soils. Kennebec soils are on flood plains, and Reading soils are in positions on the landscape similar to those of the Chase soils.

Typical pedon of Chase silty clay loam, 1,900 feet east and 75 feet south of the northwest corner of sec. 11, T. 2 S., R. 12 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; neutral; abrupt smooth boundary.

A12—8 to 13 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

A13—13 to 17 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

B21t—17 to 30 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; very hard, very firm; few fine roots; shiny faces on nearly all peds; mildly alkaline; gradual smooth boundary.

B22t—30 to 37 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common fine faint dark brown (10YR 3/3) mottles; moderate fine blocky structure; very hard, very firm; few fine roots; shiny faces on nearly all peds; few fine pebbles; mildly alkaline; gradual smooth boundary.

B3—37 to 42 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine faint brown (10YR 5/3) mottles; weak fine blocky structure; very hard, firm; few fine roots; few fine soft lime masses; few coarse sand grains; many fine pores; moderately alkaline; gradual smooth boundary.

C—42 to 60 inches; grayish brown (10YR 5/2) silty clay loam, gray (10YR 6/1) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium blocky structure; hard, firm; few fine lime concretions; many fine pores; few coarse sand grains; moderately alkaline.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is more than 36 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is silt loam or silty clay loam. It is medium acid to neutral. The B2t horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 6 dry), and chroma of 1 or 2. It is silty clay loam or silty clay. It is slightly acid to mildly alkaline. The C horizon has the same color range as the B horizon. It is silty clay loam or silty clay. It ranges from slightly acid to moderately alkaline. Many pedons have fine concretions or soft masses of lime.

Elmont series

The Elmont series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in residuum of noncalcareous, silty shale that is stratified with fine grained sandstone in some areas. Slope ranges from 3 to 7 percent.

Elmont soils are similar to Sibleyville soils and commonly are adjacent to Pawnee, Sibleyville, and

Vinland Variant soils. Sibleyville soils are less than 40 inches deep over bedrock. They are on ridgetops or the upper side slopes. Pawnee soils have a clayey subsoil. They are on ridgetops or the upper side slopes. Vinland Variant soils do not have an argillic horizon. They are on the steeper upper side slopes and on narrow ridgetops.

Typical pedon of Elmont silt loam, 3 to 7 percent slopes, 2,000 feet north and 750 feet west of the southeast corner of sec. 23, T. 1 S., R. 12 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; hard, friable; common fine roots; medium acid; clear smooth boundary.

A12—6 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; hard, friable; common fine roots; medium acid; gradual smooth boundary.

B21t—9 to 16 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure; hard, firm; common fine roots; medium acid; gradual smooth boundary.

B22t—16 to 26 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; common fine faint strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

B3—26 to 37 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

C—37 to 45 inches; mixed yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) silty clay loam, brownish yellow (10YR 6/6) and reddish yellow (7.5YR 6/6) dry; weak medium blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

Cr—45 inches; shale.

The solum ranges from 24 to 50 inches in thickness. It is medium acid to neutral. The depth to shale ranges from 40 to 60 inches. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is dominantly silt loam, but the range includes clay loam and silty clay loam. The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The C horizon has hue of 5YR, 7.5YR, 10YR, or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 6. It is silty clay loam or clay loam.

Kennebec series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on flood plains and foot slopes. These soils formed in silty alluvium. Slope ranges from 0 to 3 percent.

Kennebec soils are similar to Reading soils and commonly are adjacent to Burchard, Olmitz, Pawnee, and Wabash soils. The well drained Reading soils are on terraces. The well drained Burchard soils are on uplands. Olmitz soils are on foot slopes. Their subsoil contains more sand than that of the Kennebec soils. Pawnee soils are on uplands. Their subsoil is more clayey than that of the Kennebec soils. The very poorly drained Wabash soils are in low areas on flood plains.

Typical pedon of Kennebec silt loam, 2,150 feet west and 50 feet south of the northeast corner of sec. 25, T. 2 S., R. 14 E.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

A12—6 to 30 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable; common fine roots; slightly acid; diffuse smooth boundary.

AC—30 to 41 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; few fine roots; slightly acid; diffuse smooth boundary.

C—41 to 60 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; few fine faint dark brown (10YR 4/3) mottles; weak fine subangular blocky structure; hard, firm; few fine roots; neutral.

The thickness of the solum and of the mollic epipedon is more than 36 inches. The depth to lime typically is more than 60 inches, but the C horizon has lime concretions in a few pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is dominantly silt loam but in some pedons is silty clay loam. It is medium acid to neutral. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 or 2. It is slightly acid or neutral. It generally is silt loam, clay loam, or silty clay loam, but the content of clay or sand, or both, varies below a depth of 40 inches.

Kipson series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum of calcareous, silty shale (fig. 10). Slope ranges from 5 to 25 percent.

Figure 10.—Profile of Kipson silty clay loam, a shallow soil that formed in calcareous shale. Depth is marked in feet.

Kipson soils commonly are adjacent to Benfield, Pawnee, and Wymore soils. Benfield soils have a clayey subsoil and are 20 to 40 inches deep over bedrock. They are on the less sloping side slopes. The deep, moderately well drained Pawnee and Wymore soils are on ridgetops and the upper side slopes.

Typical pedon of Kipson silty clay loam, 5 to 25 percent slopes, 1,400 feet north and 100 feet west of the southeast corner of sec. 30, T. 1 S., R. 12 W.

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; many fine roots; about 3 percent thin limestone fragments; slight effervescence; moderately alkaline; gradual smooth boundary.

C—9 to 19 inches; olive brown (2.5Y 4/4) shaly silty clay loam, light olive brown (2.5Y 5/4) dry; moderate fine platy structure; hard, friable; common fine roots; about 5 percent thin limestone fragments and 15 percent shale fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cr—19 inches; calcareous shale.

The thickness of the solum ranges from 6 to 12 inches. The depth to shale ranges from 7 to 20 inches. Typically, the soils contain lime throughout, but in some pedons the upper 1 to 3 inches contains no lime. In some pedons thin, flat limestone fragments or angular chert fragments are at the surface.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam and clay loam. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It is shaly silty clay loam, shaly silt loam, shaly loam, silty clay loam, or silt loam.

Morrill series

The Morrill series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in glacial till. Slope ranges from 4 to 8 percent.

Morrill soils are similar to Burchard and Olmitz soils and commonly are adjacent to Burchard, Pawnee, and Steinauer soils. Burchard soils do not have a reddish subsoil. Olmitz soils are on foot slopes. Their mollic epipedon is thicker than that of the Morrill soils. Pawnee soils have a clayey subsoil. Their position on the landscape is similar to that of the Morrill soils. Steinauer soils do not have a mollic epipedon. They generally are steeper than the Morrill soils.

Typical pedon of Morrill loam, 4 to 8 percent slopes, 1,450 feet south and 700 feet east of the northwest corner of sec. 8, T. 4 S., R. 14 E.

A1—0 to 10 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 4/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; about 5 percent fine gravel; medium acid; gradual smooth boundary.

B1—10 to 15 inches; dark reddish brown (5YR 3/3) clay loam, reddish brown (5YR 4/3) dry; moderate fine granular structure; hard, firm; common fine roots;

about 5 percent fine gravel; medium acid; gradual smooth boundary.

B2t—15 to 29 inches; dark reddish brown (5YR 3/4) clay loam, reddish brown (5YR 4/4) dry; moderate fine and medium subangular blocky structure; hard, firm; few fine roots; about 5 percent fine gravel; medium acid; gradual smooth boundary.

B3—29 to 41 inches; yellowish red (5YR 4/6) clay loam, yellowish red (5YR 5/6) dry; weak fine subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

C—41 to 60 inches; brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; massive; hard, firm; slightly acid.

The solum ranges from 30 to 60 inches in thickness. It is neutral to strongly acid. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is dominantly loam or clay loam, but the range includes sandy loam. The B2t horizon has hue of 7.5YR or 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 5. It is sandy clay loam, gravelly clay loam, or clay loam. The B3 and C horizons have hue of 10YR to 5YR, value of 4 or 5 (4 to 6 dry), and chroma of 3 to 6. They are sandy clay loam, clay loam, or gravelly clay loam. The C horizon is medium acid to neutral.

Olmitz series

The Olmitz series consists of deep, moderately well drained, moderately permeable soils on foot slopes. These soils formed in loamy alluvium. Slope ranges from 1 to 5 percent.

Olmitz soils are similar to Burchard and Morrill soils and commonly are adjacent to Burchard, Kennebec, Pawnee, and Steinauer soils. Burchard and Morrill soils are on uplands. The mollic epipedon of Burchard soils is thinner than that of the Olmitz soils. The subsoil of Morrill soils is redder than that of the Olmitz soils. Kennebec soils are on flood plains. Their subsoil contains less sand than that of the Olmitz soils. Pawnee soils are on the steeper upper side slopes and on narrow ridgetops. Their subsoil is more clayey than that of the Olmitz soils. Steinauer soils lack a mollic epipedon and have lime within 14 inches of the surface. They are steeper than the Olmitz soils.

Typical pedon of Olmitz loam, 1 to 5 percent slopes, 1,700 feet south and 150 feet east of the northwest corner of sec. 18, T. 4 S., R. 1 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

A12—6 to 16 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine and fine subangular blocky structure; slightly hard, friable; common fine roots; medium acid; gradual smooth boundary.

A13—16 to 25 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; few fine roots; slightly acid; gradual smooth boundary.

A3—25 to 32 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; slightly acid; diffuse smooth boundary.

B2—32 to 44 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; few fine faint dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; hard, friable; few fine roots; slightly acid; diffuse smooth boundary.

B3—44 to 60 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; common fine and medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; hard, friable; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is loam or clay loam. It ranges from strongly acid to neutral. The B2 horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. It is strongly acid to slightly acid.

Pawnee series

The Pawnee series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in glacial till. Slope ranges from 1 to 8 percent.

Pawnee soils are similar to Benfield and Wymore soils and commonly are adjacent to those soils and to Burchard soils. Benfield soils are 20 to 40 inches deep over bedrock. They are on narrow ridgetops and on side slopes. Wymore soils are on broad ridgetops and the upper side slopes. Their subsoil contains less sand than that of the Pawnee soils. Burchard soils are on the lower side slopes. Their subsoil is less clayey than that of the Pawnee soils.

Typical pedon of Pawnee clay loam, 4 to 8 percent slopes (fig. 11), 2,250 feet west and 150 feet north of the southeast corner of sec. 11, T. 2 S., R. 14 E.

Ap—0 to 4 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine blocky structure; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

A12—4 to 9 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable; common fine roots; neutral; gradual smooth boundary.

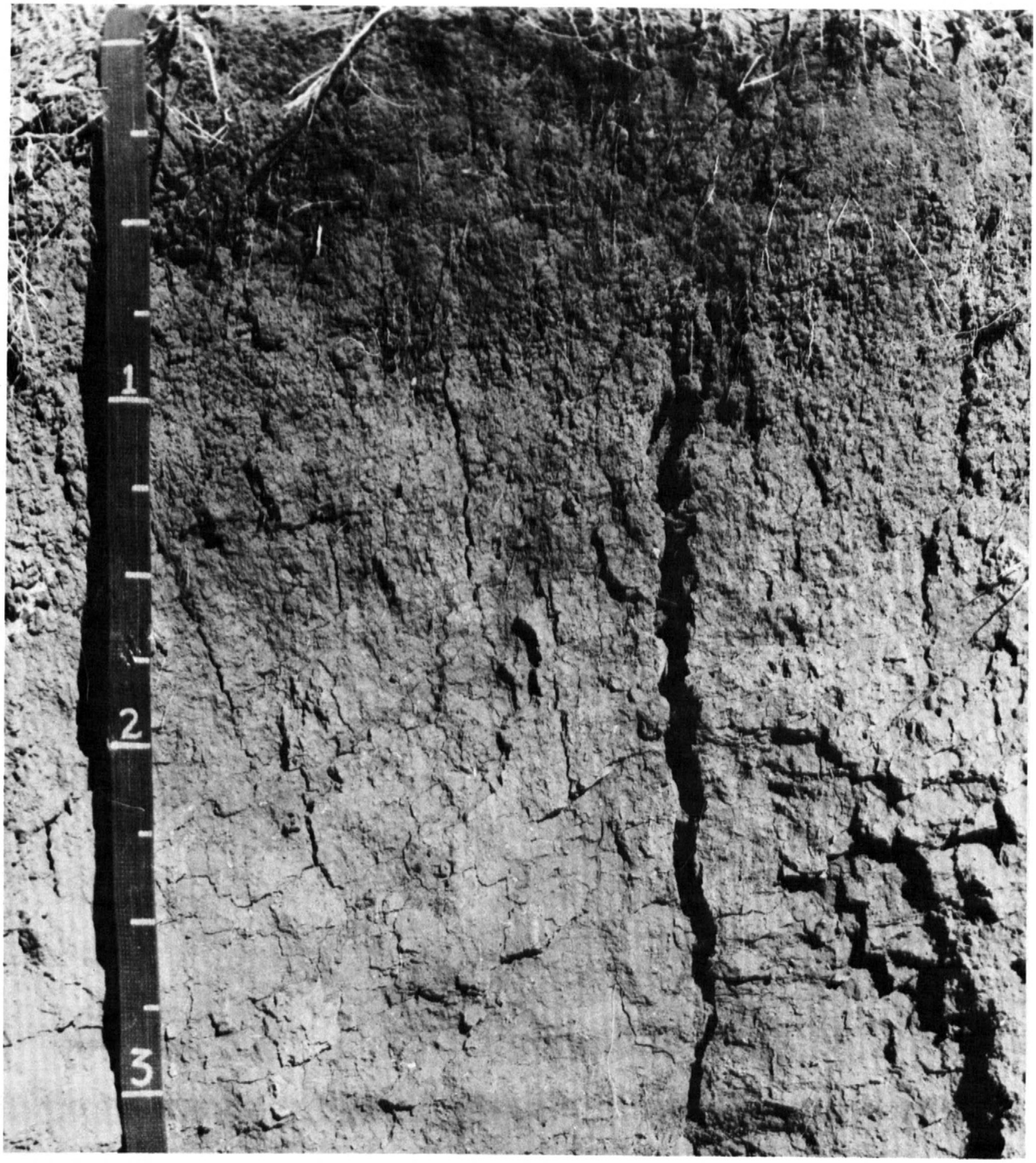

Figure 11.—Profile of Pawnee clay loam. The large crack in the subsoil is characteristic of soils that have a high shrink-swell potential. Depth is marked in feet.

B1—9 to 15 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 5/3) dry; few fine distinct brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; hard, firm; common fine roots; neutral; gradual smooth boundary.

B21t—15 to 27 inches; dark grayish brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; many fine and medium distinct brown (7.5YR 4/4) mottles; moderate fine blocky structure; very hard, very firm; few fine roots; a few pebbles; neutral; gradual smooth boundary.

B22t—27 to 41 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; many fine and medium distinct brown (7.5YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; a few pebbles; neutral; gradual smooth boundary.

B3—41 to 51 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; many medium prominent strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; few fine and medium lime concretions; a few pebbles; few fine black concretions; mildly alkaline; gradual smooth boundary.

C—51 to 60 inches; mixed light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) clay loam, light gray (2.5Y 7/2) and brownish yellow (10YR 6/6) dry; moderate medium blocky structure; very hard, firm; few fine and medium lime concretions; a few pebbles; few fine black concretions; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. It is dominantly free of lime, but the lower part of the B horizon has a few lime concretions. The mollic epipedon ranges from 10 to 19 inches in thickness and includes the upper part of the B horizon.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly clay loam or clay but in some pedons is loam. It is medium acid to neutral. The B2t horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It ranges from slightly acid to moderately alkaline. The C horizon dominantly has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 4. It is clay loam or sandy clay loam. It is mildly alkaline or moderately alkaline.

Reading series

The Reading series consists of deep, well drained, moderately permeable soils on terraces. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

Reading soils are similar to Kennebec soils and commonly are adjacent to Chase, Kennebec, and Wabash soils. The moderately well drained Kennebec soils are on flood plains. Chase and Wabash soils have a clayey subsoil. The somewhat poorly drained Chase soils are on terraces, and the very poorly drained Wabash soils are in low areas on flood plains.

Typical pedon of Reading silt loam, 1,220 feet south and 2,950 feet west of the northeast corner of sec. 19, T. 1 S., R. 12 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; hard, friable; common fine roots; slightly acid; abrupt smooth boundary.

A12—6 to 16 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, friable; common fine roots; slightly acid; gradual smooth boundary.

B1—16 to 26 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, friable; common fine roots; slightly acid; gradual smooth boundary.

B2t—26 to 49 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

B3—49 to 60 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common fine faint dark yellowish brown (10YR 4/6) mottles; moderate medium prismatic structure parting to weak medium subangular blocky; hard, firm; slightly acid.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon is more than 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is silt loam or silty clay loam. It ranges from medium acid to neutral. The B2t horizon has hue of 10YR or 7.5YR, value of 2 to 4 (3 to 5 dry), and chroma of 2 to 4. It is medium acid or slightly acid. The B3 horizon is silty clay loam, clay loam, or silty clay.

Sibleyville series

The Sibleyville series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in residuum of sandstone and of sandy and silty shale. Slope ranges from 4 to 8 percent.

Sibleyville soils are similar to Elmont and Vinland Variant soils and commonly are adjacent to those soils and to Kipson soils. Elmont soils are more than 40 inches deep over bedrock. They are lower on the landscape than the Sibleyville soils. Vinland Variant and Kipson soils are on the steeper side slopes. Vinland Variant soils contain less clay in the B horizon than the Sibleyville soils. Kipson soils are less than 20 inches deep over bedrock.

Typical pedon of Sibleyville loam, 4 to 8 percent slopes, 1,450 feet east and 50 feet south of the northwest corner of sec. 24, T. 1 S., R. 12 E.

A1—0 to 9 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 4/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.
B1—9 to 14 inches; dark brown (7.5YR 3/2) and brown (7.5YR 4/4) loam, brown (7.5YR 4/2 and 5/4) dry; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.
B2t—14 to 23 inches; brown (7.5YR 4/4) loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; medium acid; gradual smooth boundary.
C—23 to 37 inches; yellowish red (5YR 4/6) channery loam, yellowish red (5YR 5/6) dry; massive; slightly hard, friable; common fine roots; about 15 percent shale fragments; medium acid; abrupt wavy boundary.
Cr—37 inches; shale.

The thickness of the solum ranges from about 14 to 34 inches. The depth to sandstone or sandy and silty shale ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (4 or 5 dry), and chroma of 2 or 3. It is loam or clay loam. It ranges from neutral to medium acid. The B2t horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 (5 to 7 dry), and chroma of 2 to 4. It is loam, clay loam, or sandy clay loam. The C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6 (5 to 7 dry), and chroma of 3 to 6. It is channery loam, channery clay loam, or channery sandy clay loam. It ranges from neutral to strongly acid.

Steinauer series

The Steinauer series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in calcareous glacial till (fig. 12). Slope ranges from 6 to 25 percent.

Steinauer soils are similar to Burchard soils and commonly are adjacent to Burchard, Olmitz, and Pawnee soils. All of the adjacent soils have a mollic epipedon. Burchard and Pawnee soils are in the smoother, less sloping areas. The moderately well drained Olmitz soils are on foot slopes below the Steinauer soils.

Typical pedon of Steinauer clay loam, in an area of Burchard-Steinauer clay loams, 6 to 12 percent slopes, 370 feet west and 1,050 feet north of the southeast corner of sec. 28, T. 4 S., R. 13 E.

Ap—0 to 6 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; moderate fine granular structure; hard, firm; many fine roots; a few pebbles; strong effervescence; moderately alkaline; clear smooth boundary.
AC—6 to 13 inches; olive brown (2.5Y 4/4) clay loam, light olive brown (2.5Y 5/4) dry; moderate fine subangular blocky structure; hard, firm; common fine roots; a few pebbles; violent effervescence; moderately alkaline; diffuse smooth boundary.
C1—13 to 39 inches; pale brown (10YR 6/3) clay loam, very pale brown (10YR 7/3) dry; common medium distinct gray (10YR 5/1) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm; few fine roots; a few pebbles; few iron stains; common pockets of soft lime; violent effervescence; moderately alkaline; diffuse smooth boundary.
C2—39 to 60 inches; grayish brown (10YR 5/2) clay loam, light brownish gray (10YR 6/2) dry; few medium faint yellowish brown (10YR 5/4) mottles; weak coarse prismatic structure; hard, firm; few fine roots; a few pebbles; few iron stains; common pockets of soft lime; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 8 to 21 inches. The depth to lime ranges from 0 to 14 inches. The content of cobbles and gravel ranges from 0 to 10 percent.

The A horizon has hue of 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 or 3. It is dominantly clay loam, but the range includes loam. The AC horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 (6 or 7 dry), and chroma of 2 to 4. It is clay loam or loam. Some pedons have seams or pockets of sand and gravel and stones.

Vinland Variant

The Vinland Variant consists of moderately deep, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum of interbedded sandy and silty shale that has thin beds of sandstone. Slope ranges from 5 to 25 percent.

Vinland Variant soils are similar to Sibleyville soils and commonly are adjacent to Elmont, Pawnee, and Sibleyville soils. Elmont soils are more than 40 inches deep over bedrock. They are on the lower side slopes. Pawnee soils have a clayey subsoil. They are on the upper side slopes and on ridgetops. Sibleyville soils are in the less sloping areas. Their subsoil contains more clay than that of the Vinland Variant soils.

Typical pedon of Vinland Variant loam, 5 to 25 percent slopes, 580 feet east and 1,940 feet north of the southwest corner of sec. 32, T. 1 S., R. 14 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; many fine and few medium roots; slightly acid; gradual smooth boundary.
B2—8 to 24 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak fine subangular blocky

Figure 12.—Profile of Steinauer clay loam, which formed in calcareous glacial till. The white spots are pockets of lime. Depth is marked in feet.

structure; slightly hard, friable; common fine and few medium roots; slightly acid; gradual smooth boundary.

C—24 to 29 inches; brown (10YR 5/3) loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable; few fine roots; slightly acid; clear wavy boundary.

Cr—29 inches; weathered interbedded sandy and silty shale.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The mollic epipedon is 8 to 12 inches thick. Reaction ranges from medium acid to mildly alkaline throughout the profile.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 to 4. The B2 horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is loam or silt loam in which the content of clay ranges from 12 to 18 percent. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 7 (5 to 8 dry), and chroma of 2 to 4. Its range in texture is like that of the B2 horizon.

Wabash series

The Wabash series consists of deep, very poorly drained soils on flood plains. Permeability is very slow. These soils formed in clayey alluvium. Slope is less than 1 percent.

Wabash soils are similar to Chase soils and commonly are adjacent to Chase, Kennebec, and Reading soils. The somewhat poorly drained Chase and well drained Reading soils are on low terraces. The moderately well drained Kennebec soils are on flood plains adjacent to streams. Their subsoil contains less clay than that of the Wabash soils.

Typical pedon of Wabash silty clay loam, 750 feet north and 75 feet east of the southwest corner of sec. 8, T. 4 S., R. 11 W.

Ap—0 to 4 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; hard, friable; common fine roots; slightly acid; abrupt smooth boundary.

A12—4 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; hard, friable; few fine roots; slightly acid; gradual smooth boundary.

A13—12 to 22 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine blocky structure; hard, firm; few fine roots; slightly acid; diffuse smooth boundary.

B1g—22 to 41 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine blocky structure; extremely hard, very firm; few fine roots; neutral; diffuse smooth boundary.

B2g—41 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine blocky structure; extremely hard, very firm; mildly alkaline.

The thickness of the solum ranges from about 40 to 60 inches. The A horizon and the upper part of the B horizon range from medium acid to neutral, and the lower part of the B horizon ranges from slightly acid to mildly alkaline. The depth to lime is more than 40 inches.

The A horizon has hue of 10YR to 5Y or is neutral. It has value of 2 or 3 (3 or 4 dry) and chroma of 2 or less. It is dominantly silty clay loam, but the range includes silty clay and silt loam. The B2 horizon has hue of 10YR to 5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 or less. It has mottles with hue of 10YR or yellower and with higher chroma. It is silty clay or clay. The content of clay in this horizon ranges from 46 to 60 percent, and the content of sand is less than 15 percent.

Wymore series

The Wymore series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slope ranges from 1 to 8 percent.

Wymore soils are similar to Benfield and Pawnee soils and commonly are adjacent to those soils. Both of the adjacent soils are on the lower side slopes. Benfield soils are 20 to 40 inches deep over bedrock. Pawnee soils contain more sand in the subsoil than the Wymore soils.

Typical pedon of Wymore silty clay loam, 1 to 4 percent slopes, 300 feet south and 1,100 feet west of the northeast corner of sec. 33, T. 1 S., R. 14 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium granular structure; hard, friable; common fine roots; medium acid; abrupt smooth boundary.

B1—6 to 9 inches; very dark brown (10YR 2/2) silty clay, very dark grayish brown (10YR 3/2) dry; moderate fine blocky structure; very hard, firm; common fine roots; slightly acid; gradual smooth boundary.

B21t—9 to 20 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium and fine blocky structure; very hard, very firm; common fine roots; neutral; gradual smooth boundary.

B22t—20 to 41 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; common fine and medium prominent yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; very hard, firm; few fine roots; neutral; gradual smooth boundary.

C—41 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; weak coarse blocky structure; hard, friable; mildly alkaline.

The solum ranges from 36 to 50 inches in thickness. It ranges from medium acid in the upper part to neutral in the lower part. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is silty clay loam or silty clay. The B2t horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is dominantly silty clay in which the content of clay ranges from 42 to 55 percent. In some pedons, however, the lower part of this horizon is silty clay loam. The C horizon has hue of 5Y or 2.5Y, value of 5 (6 dry), and chroma of 1 or 2.

formation of the soils

The characteristics of a soil at any given place are determined by the interaction among five factors of soil formation—climate, plant and animal life, parent material, relief, and time. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The effects of the individual factors vary from place to place. The interactions among the factors are more complex for some soils than for others.

Climate and vegetation act on the parent material and gradually change it to a natural body of soil. Relief modifies the effects of climate and vegetation, mainly through its effect on runoff and temperature. The nature of the parent material also affects the kind of soil that forms. Time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons.

The paragraphs that follow relate the five factors of soil formation to the soils in the survey area.

parent material

Parent material is the weathered rock or partly weathered material in which soils form. It affects texture, structure, color, natural fertility, and many other soil properties. The soils in Nemaha County formed in alluvium, glacial till, loess, and residuum of shale, sandstone, and thin strata of limestone.

Alluvium is sediment deposited by floodwater in stream valleys. Calco, Chase, Kennebec, Olmitz, Reading, and Wabash soils formed in these deposits.

Kansan glacial till covers many of the uplands in the county. It is a fine earth mixture of silt, sand, and clay left by glaciers. It contains pebbles and a few stones or boulders. It also has pockets of sand and gravel in a few places. Burchard, Morrill, Pawnee, and Steinauer soils formed in glacial till.

Loess is silty windborne material that is sometimes carried hundreds of miles from its source. Peorian Loess of the Wisconsin Stage was deposited during the Pleistocene. Wymore soils formed in this material.

Upper Pennsylvanian and Lower Permian bedrock crops out in the county. It is sandstone and shale and thin strata of limestone. Benfield, Elmont, Kipson, Sibleyville, and Vinland Variant soils formed in residuum of these rocks.

climate

Climate is an active factor of soil formation. It directly affects the formation of a soil by weathering the parent material. It indirectly affects soil formation through its effect on the plants and animals on or in the soil.

The climate of Nemaha County is continental. It is characterized by intermittent dry and moist periods. These periods can last for less than a year or for several years. The soil dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. The accumulation of soft lime in the substratum of Burchard soils is evidence of this excess moisture. As a result of this wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons of some soils.

plant and animal life

Plants generally affect the content of nutrients and of organic matter in the soil and the color of the surface layer. Earthworms, cicadas, burrowing animals, and other animals help to keep the soil open and porous. Earthworms have left worm casts in some soils. Bacteria and fungi help to decompose the plants, thus releasing plant nutrients.

The mid and tall prairie grasses have affected soil formation in Nemaha County more significantly than other forms of plant and animal life. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. The next part in many areas is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color and high in content of lime.

relief

Relief affects soil formation through its effect on drainage, runoff, plant cover, and soil temperature. The soil temperature, for example, is slightly lower on east- and north-facing slopes than on west- and south-facing slopes. Most important is the effect of relief on the movement of water on the surface and into the soil.

The runoff rate is higher on the steeper soils in the uplands than on the less steep soils. As a result, erosion is more extensive. Relief has retarded the formation of Kipson soils, which formed in old parent material. Runoff is rapid on these moderately sloping to moderately steep soils, and much of the soil material is removed as soon as the soil forms.

Soils having distinct horizons generally formed in the less sloping areas, where runoff is slow. The nearly level Reading soils on stream terraces, for example, formed in the younger parent material in the county but have distinct horizons. Most of the precipitation received by these soils penetrates the surface.

time

Differences in the length of time that the parent materials have been in place commonly are reflected in the degree of profile development. The soils in Nemaha County range from immature to mature. Those in low areas on bottom land, such as Kennebec soils, are subject to stream overflow. They receive new sediment with each flood. They have a thick, dark surface layer, but they have weakly expressed horizons. As a result, they are considered immature. Clay has accumulated in the subsoil of mature soils. Examples are Wymore and Pawnee soils.

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glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concen .ted compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among

different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil

horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor

aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a

series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium absorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity are—

	SAR
Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-76 at Centralia, Kansas]

Month	Temperature					Precipitation				
				2 years in 10 will have--			2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January-----	36.5	15.1	25.8	65	-15	0.95	0.17	1.91	3	5.6
February---	43.6	20.7	32.2	74	-9	1.14	0.45	1.93	3	5.2
March-------	52.2	28.5	40.4	82	-1	1.97	0.55	2.85	4	3.8
April-------	66.1	40.8	53.5	88	18	2.87	1.38	3.77	6	0.7
May---------	75.8	51.7	63.8	92	30	4.65	2.70	6.00	8	0.0
June--------	84.7	61.6	73.2	99	44	5.35	2.39	8.41	8	0.0
July--------	90.1	66.4	78.3	106	49	4.18	1.38	6.26	6	0.0
August------	88.7	64.7	76.7	103	46	3.90	1.86	5.42	6	0.0
September--	80.0	55.3	67.7	100	34	4.25	1.54	7.10	6	0.0
October-----	69.9	44.4	57.2	92	21	2.63	0.80	4.50	4	0.1
November---	53.2	30.6	41.9	76	4	1.61	0.16	2.61	3	1.8
December---	40.8	20.5	30.7	68	-9	0.93	0.39	1.44	2	4.7
Year------	65.1	41.7	53.4	106	-15	34.43	26.09	42.61	59	21.9

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 15	April 27	May 12
2 years in 10 later than--	April 10	April 22	May 7
5 years in 10 later than--	April 1	April 12	April 27
First freezing temperature in fall:			
1 year in 10 earlier than--	October 17	October 9	September 29
2 years in 10 earlier than--	October 22	October 14	October 3
5 years in 10 earlier than--	November 1	October 23	October 13

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	194	172	146
8 years in 10	201	180	154
5 years in 10	214	194	169
2 years in 10	228	209	185
1 year in 10	235	217	193

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Bf	Benfield silty clay loam, 5 to 9 percent slopes	6,000	1.3
Bs	Burchard-Steinauer clay loams, 6 to 12 percent slopes	108,900	24.1
Cc	Calco silty clay loam	600	0.1
Ch	Chase silty clay loam	2,400	0.5
Et	Elmont silt loam, 3 to 7 percent slopes	1,700	0.4
Ke	Kennebec silt loam	45,300	10.0
Kn	Kennebec silt loam, channeled	1,200	0.3
Kp	Kipson silty clay loam, 5 to 25 percent slopes	9,200	2.0
Mb	Morrill loam, 4 to 8 percent slopes	2,050	0.5
Me	Morrill clay loam, 4 to 8 percent slopes, eroded	850	0.2
Om	Olmitz loam, 1 to 5 percent slopes	5,200	1.1
Pa	Pawnee clay loam, 1 to 4 percent slopes	72,600	16.0
Pb	Pawnee clay loam, 4 to 8 percent slopes	97,700	21.5
Pe	Pawnee clay, 4 to 8 percent slopes, eroded	8,900	2.0
Pt	Pits, quarries	234	0.1
Re	Reading silt loam	2,450	0.5
Sb	Sibleyville loam, 4 to 8 percent slopes	450	0.1
St	Steinauer clay loam, 12 to 25 percent slopes	3,700	0.8
Vv	Vinland Variant loam, 5 to 25 percent slopes	550	0.1
Wa	Wabash silty clay loam	6,700	1.5
Wb	Wymore silty clay loam, 1 to 4 percent slopes	72,300	15.9
Wc	Wymore silty clay loam, 4 to 8 percent slopes	4,200	0.9
	Water	576	0.1
	Total	453,760	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum	Corn	Soybeans	Winter wheat	Smooth bromegrass	Alfalfa hay
	Bu	Bu	Bu	Bu	AUM*	Ton
Bf: Benfield	60	55	25	36	4.8	3.0
Bs: Burchard-Steinauer	70	65	30	36	5.0	3.2
Ch: Chase	85	85	36	50	7.5	5.0
Et: Elmont	75	80	32	40	6.5	3.6
Ke: Kennebec	90	100	40	48	6.5	5.0
Kn: Kennebec	---	---	---	---	6.5	---
Mb: Morrill	80	80	32	42	6.5	3.6
Me: Morrill	70	70	30	38	6.0	3.2
Om: Olmitz	90	95	40	48	6.0	4.5
Pa: Pawnee	70	68	30	40	5.5	3.4
Pb: Pawnee	65	64	26	36	5.0	3.1
Pe: Pawnee	60	58	25	32	4.0	2.8
Re: Reading	95	100	44	52	6.5	5.0
Sb: Sibleyville	60	52	24	38	5.5	---
Vv: Vinland Variant	---	---	---	---	4.0	---
Wa: Wabash	80	70	32	40	5.5	3.0
Wb: Wymore	75	75	32	44	5.5	3.7
Wc: Wymore	70	65	28	40	5.0	3.3

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Bf: Benfield	Loamy Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Leadplant	5
				Sideoats grama	5
Bs*:					
Burchard	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
Steinauer	Limy Upland	Favorable	4,500	Little bluestem	35
		Normal	3,500	Big bluestem	15
		Unfavorable	2,200	Sideoats grama	10
				Indiangrass	10
				Switchgrass	5
Ch: Chase	Loamy Lowland	Favorable	9,000	Big bluestem	40
		Normal	7,000	Indiangrass	10
		Unfavorable	5,000	Switchgrass	10
				Eastern gamagrass	10
				Little bluestem	5
				Prairie cordgrass	5
Et: Elmont	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	5
Ke, Kn: Kennebec	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Kp: Kipson	Limy Upland	Favorable	4,500	Big bluestem	25
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
				Leadplant	5
				Jersey tea	5
Mb, Me: Morrill	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	5
Om: Olmitz	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Pa, Pb, Pe: Pawnee	Loamy Upland	Favorable	5,000	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	3,500	Switchgrass	10
				Sideoats grama	5
				Indiangrass	5
Re: Reading	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Sb: Sibleyville	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	5
St: Steinauer	Limy Upland	Favorable	4,500	Little bluestem	35
		Normal	3,500	Big bluestem	15
		Unfavorable	2,200	Sideoats grama	10
				Indiangrass	10
				Switchgrass	5
Vv: Vinland Variant	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	15
				Switchgrass	5
				Sideoats grama	5
Wa: Wabash	Clay Lowland	Favorable	10,000	Prairie cordgrass	30
		Normal	9,000	Switchgrass	15
		Unfavorable	7,000	Big bluestem	15
				Eastern gamagrass	15
				Indiangrass	10
Wb, Wc: Wymore	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,500	Switchgrass	10
				Indiangrass	5
				Sideoats grama	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Common trees	Site index	
Ch----------------- Chase	3c	Slight	Moderate	Moderate	Slight	Bur oak------------- Common hackberry---- Green ash----------- Eastern cottonwood-- Black walnut--------	62 69 60 66 55	Green ash, eastern cottonwood.
Ke, Kn------------- Kennebec	2o	Slight	Slight	Slight	Moderate	Black walnut-------- Bur oak------------- Common hackberry---- Green ash----------- Eastern cottonwood--	79 63 --- --- ---	Black walnut, bur oak, common hackberry, green ash, eastern cottonwood, American sycamore.
Re----------------- Reading	2o	Slight	Slight	Slight	Moderate	Black walnut-------- Common hackberry---- Bur oak------------- Shagbark hickory---- Northern red oak----	73 69 60 62 ---	Black walnut, green ash, common hackberry, bur oak, eastern cottonwood, northern red oak.
Sb----------------- Sibleyville	5o	Slight	Slight	Slight	Slight	White oak----------- Chinkapin oak------- Shagbark hickory---- Black walnut-------- Green ash-----------	50 --- --- --- ---	White oak, green ash, bur oak, common hackberry, northern red oak.
Vv----------------- Vinland Variant	5o	Slight	Slight	Moderate	Slight	White oak----------- Black walnut-------- Chinkapin oak-------	50 50 50	White oak, green ash.
Wa----------------- Wabash	4w	Slight	Severe	Moderate	Severe	Pin oak------------- Eastern cottonwood-- Green ash-----------	75 --- ---	Pin oak, eastern cottonwood, green ash.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Bf-----------------Benfield	Siberian peashrub, Peking cotoneaster, lilac.	Amur honeysuckle	Eastern redcedar, Austrian pine, Russian-olive, common hackberry, green ash.	Siberian elm, honeylocust.	---
Bs*:					
Burchard----------	Peking cotoneaster	Tatarian honeysuckle, lilac, American plum.	Eastern redcedar, Russian mulberry, green ash, common hackberry, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
Steinauer---------	American plum-----	Eastern redcedar, Siberian peashrub, Russian-olive, Tatarian honeysuckle, common hackberry.	Ponderosa pine, Siberian elm, honeylocust, green ash.	---	---
Cc-----------------Calco	---	Tatarian honeysuckle, American plum, Siberian peashrub.	Common hackberry, eastern redcedar, Russian-olive.	Green ash, honeylocust, Siberian elm, ponderosa pine.	Eastern cottonwood.
Ch-----------------Chase	Fragrant sumac----	Amur honeysuckle, Peking cotoneaster.	Eastern redcedar, Siberian crabapple.	Austrian pine, pin oak, green ash, common hackberry, honeylocust.	Silver maple, eastern cottonwood.
Et-----------------Elmont	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, Russian-olive, common hackberry, green ash, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
Ke, Kn-------------Kennebec	Gray dogwood------	Tatarian honeysuckle, American plum, purpleosier willow, redosier dogwood.	Eastern redcedar--	Common hackberry, Norway spruce, Austrian pine, honeylocust, green ash.	Silver maple, eastern cottonwood.
Kp. Kipson					
Mb, Me-------------Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, common hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Om-----------------Olmitz	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Eastern redcedar, Russian mulberry, common hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Pa, Pb, Pe: Pawnee	Amur honeysuckle, lilac, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, midwest Manchurian crabapple.	Austrian pine, Russian-olive, green ash, honeylocust, common hackberry.	Siberian elm	---
Pt*. Pits					
Re: Reading	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, bur oak, green ash, Russian-olive, common hackberry.	Austrian pine, honeylocust, Scotch pine.	---
Sb: Sibleyville	Peking cotoneaster, lilac, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, common hackberry, bur oak, Russian-olive, Austrian pine, green ash.	Honeylocust, Siberian elm.	---
St: Steinauer	American plum	Eastern redcedar, Siberian peashrub, Russian-olive, Tatarian honeysuckle, common hackberry.	Ponderosa pine, Siberian elm, honeylocust, green ash.	---	---
Vv: Vinland Variant	Fragrant sumac, lilac, common chokecherry.	Amur honeysuckle, autumn-olive, Amur maple.	Eastern redcedar, green ash, common hackberry.	Austrian pine, honeylocust, Scotch pine.	---
Wa: Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, common hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Wb, Wc: Wymore	Peking cotoneaster, skunkbush sumac, lilac.	Amur honeysuckle	Eastern redcedar, Austrian pine, ponderosa pine, Russian-olive, common hackberry, green ash.	Honeylocust	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bf: Benfield	Slight	Slight	Severe: slope.	Severe: erodes easily.
Bs*:				
Burchard	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
Steinauer	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
Cc: Calco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
Ch: Chase	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, flooding, percs slowly.	Severe: erodes easily.
Et: Elmont	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
Ke: Kennebec	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Kn: Kennebec	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Kp: Kipson	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: small stones, depth to rock.	Moderate: slope.
Mb, Me: Morrill	Slight	Slight	Severe: slope.	Slight.
Om: Olmitz	Slight	Slight	Moderate: slope.	Slight.
Pa, Pb: Pawnee	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Severe: erodes easily.
Pe: Pawnee	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey, erodes easily.
Pt*. Pits				
Re: Reading	Severe: flooding.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.
Sb: Sibleyville	Slight	Slight	Moderate: slope, small stones.	Slight.
St: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Vv: Vinland Variant	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Wa: Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Wb, Wc: Wymore	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Severe: erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
Bf: Benfield	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Bs*:									
Burchard	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Steinauer	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Cc: Calco	Very poor	Poor	Good	Fair	Good	Good	Poor	Good	---
Ch: Chase	Good	Good	Good	Good	Good	Fair	Good	Fair	---
Et: Elmont	Fair	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
Ke: Kennebec	Good	Good	Good	---	Poor	Poor	Good	Poor	---
Kn: Kennebec	Poor	Poor	Good	---	Poor	Poor	Poor	Poor	---
Kp: Kipson	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Mb, Me: Morrill	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Om: Olmitz	Good	Good	Fair	---	Poor	Poor	Good	Poor	---
Pa: Pawnee	Good	Good	Good	Fair	Very poor	Good	Good	Poor	Fair.
Pb, Pe: Pawnee	Fair	Good	Good	Fair	Very poor	Good	Good	Poor	Fair.
Pt*. Pits									
Re: Reading	Good	Good	Good	Good	Poor	Poor	Good	Poor	---
Sb: Sibleyville	Fair	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
St: Steinauer	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Vv: Vinland Variant	Poor	Fair	Good	---	Very poor	Very poor	Fair	Very poor	---
Wa: Wabash	Poor	Poor	Poor	---	Good	Good	Poor	Good	---
Wb: Wymore	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
Wc: Wymore	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bf: Benfield	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Bs*:					
Burchard	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Steinauer	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Cc: Calco	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.
Ch: Chase	Severe: wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, shrink-swell.	Severe: low strength, flooding, frost action.
Et: Elmont	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
Ke, Kn: Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.
Kp: Kipson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.
Mb, Me: Morrill	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Om: Olmitz	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Pa, Pb, Pe: Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.
Pt*. Pits					
Re: Reading	Moderate: too clayey.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.
Sb: Sibleyville	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: frost action.
St: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.
Vv: Vinland Variant	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Wa----------------- Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Wb, Wc------------ Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Bf-----------------Benfield	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Bs*:					
Burchard-----------	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Steinauer----------	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Cc-----------------Calco	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness.
Ch-----------------Chase	Severe: flooding, wetness, percs slowly.	Slight-----------	Severe: flooding, too clayey.	Severe: flooding.	Poor: too clayey, hard to pack.
Et-----------------Elmont	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey.
Ke, Kn-------------Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Kp-----------------Kipson	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Mb, Me-------------Morrill	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Om-----------------Olmitz	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Pa-----------------Pawnee	Severe: percs slowly, wetness.	Slight-----------	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pb, Pe-------------Pawnee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Re-----------------Reading	Moderate: percs slowly.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey, thin layer.
Sb-----------------Sibleyville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
St: Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Vv: Vinland Variant	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
Wa: Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Wb: Wymore	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Wc: Wymore	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Bf: Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Bs*:				
Burchard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Cc: Calco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ch: Chase	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Et: Elmont	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Ke, Kn: Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Kp: Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Mb, Me: Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Om: Olmitz	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Pa, Pb: Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Pe: Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Pt*. Pits				
Re: Reading	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sb: Sibleyville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
St: Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Vv: Vinland Variant	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Wa-------------------- Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Wb, Wc---------------- Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Bf----------------- Benfield	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Bs*:						
Burchard----------	Severe: slope.	Slight----------	Deep to water	Slope----------	Slope----------	Slope.
Steinauer---------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.
Cc----------------- Calco	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness---------	Wetness.
Ch----------------- Chase	Slight----------	Severe: hard to pack.	Percs slowly, flooding, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Et----------------- Elmont	Moderate: depth to rock, slope.	Moderate: thin layer.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Ke, Kn------------- Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding--------	Favorable-------	Favorable.
Kp----------------- Kipson	Severe: depth to rock, slope.	Severe: piping, thin layer.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Mb, Me------------- Morrill	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope----------	Favorable-------	Favorable.
Om----------------- Olmitz	Moderate: seepage, slope.	Slight----------	Deep to water	Slope----------	Favorable-------	Favorable.
Pa----------------- Pawnee	Slight----------	Severe: hard to pack.	Percs slowly, frost action.	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
Pb----------------- Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
Pe----------------- Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slow intake, percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
Pt*. Pits						
Re----------------- Reading	Moderate: seepage.	Slight----------	Deep to water	Favorable-------	Erodes easily	Erodes easily.
Sb----------------- Sibleyville	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
St----------------- Steinauer	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Vv: Vinland Variant	Severe: slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Wa: Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Wb: Wymore	Slight	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Wc: Wymore	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Bf---------------- Benfield	0-6	Silty clay loam	CL	A-6, A-7	0-15	85-100	85-100	85-95	85-95	30-50	11-25
	6-37	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-15	85-100	70-100	70-95	70-95	40-60	20-35
	37	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bs*: Burchard----------	0-10	Clay loam----------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	10-17	Clay loam----------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	17-60	Clay loam----------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	15-30
Steinauer----------	0-6	Clay loam----------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	6-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	90-100	60-75	20-45	10-26
Cc---------------- Calco	0-17	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	17-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
Ch---------------- Chase	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-25
	17-60	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	95-100	90-100	35-60	20-40
Et---------------- Elmont	0-9	Silt loam----------	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-40	6-15
	9-45	Silty clay loam, clay loam.	CL	A-6, A-7-6	0	100	100	95-100	85-100	35-45	15-25
	45	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ke, Kn------------ Kennebec	0-41	Silt loam----------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	41-60	Silt loam, silty clay loam, clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
Kp---------------- Kipson	0-9	Silty clay loam	CL, ML, MH	A-6, A-7	0-25	80-100	70-100	65-100	60-95	35-55	10-20
	9-19	Shaly silt loam, shaly silty clay loam, shaly loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	19	Weathered bedrock	---	---	---	---	---	---	---	---	---
Mb---------------- Morrill	0-10	Loam--------------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-35	7-15
	10-60	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	30-45	11-25
Me---------------- Morrill	0-6	Clay loam----------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-35	7-15
	6-60	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	30-45	11-25
Om---------------- Olmitz	0-25	Loam--------------	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	25-60	Clay loam----------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
Pa, Pb------------ Pawnee	0-15	Clay loam----------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	15-51	Clay--------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	51-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
Pe---------------- Pawnee	0-6	Clay--------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	6-40	Clay--------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	40-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Pt*. Pits											
Re---------------- Reading	0-16	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	16-49	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-30
	49-60	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	80-100	35-50	15-30
Sb---------------- Sibleyville	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0	100	85-100	80-100	60-80	20-35	5-15
	9-23	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	100	85-100	80-90	40-60	30-40	11-20
	23-37	Channery loam, channery clay loam, channery sandy clay loam.	SC, SM-SC	A-4, A-6, A-2	0-20	70-90	70-90	60-80	20-40	20-35	5-15
	37	Weathered bedrock	---	---	---	---	---	---	---	---	---
St---------------- Steinauer	0-6	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	6-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	90-100	60-75	20-45	10-26
Vv---------------- Vinland Variant	0-8	Loam-------------	CL, CL-ML	A-4	0	95-100	90-100	85-100	85-100	20-30	5-10
	8-29	Loam, silt loam	CL, CL-ML	A-4	0	95-100	90-100	85-100	80-90	20-30	5-10
	29	Weathered bedrock	---	---	---	---	---	---	---	---	---
Wa---------------- Wabash	0-12	Silty clay loam	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	12-35
	12-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
Wb, Wc------------ Wymore	0-6	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	95-100	95-100	35-55	11-25
	6-41	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	55-70	30-42
	41-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
Bf----------------- Benfield	0-6	20-35	1.30-1.40	0.2-2.0	0.21-0.24	6.1-7.8	Moderate-----	0.37	3	7	1-4
	6-37	35-45	1.35-1.45	0.06-0.2	0.18-0.22	6.6-8.4	High---------	0.37			
	37	---	---	---	---	---	-------------	----			
Bs*:											
Burchard---------	0-10	27-35	1.40-1.60	0.2-0.6	0.17-0.19	5.6-7.3	Moderate-----	0.28	5	6	2-4
	10-17	27-35	1.40-1.60	0.2-0.6	0.15-0.17	6.1-8.4	Moderate-----	0.28			
	17-60	27-35	1.40-1.60	0.2-0.6	0.14-0.16	6.6-8.4	Moderate-----	0.28			
Steinauer--------	0-6	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate-----	0.32	5	4L	.5-2
	6-60	16-30	1.30-1.60	0.2-2.0	0.14-0.19	7.9-8.4	Moderate-----	0.32			
Cc----------------- Calco	0-17	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28	5	7	2-4
	17-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28			
Ch----------------- Chase	0-17	27-35	1.30-1.45	0.2-0.6	0.21-0.23	5.6-7.3	Moderate-----	0.37	5	7	2-4
	17-60	27-50	1.35-1.45	0.06-0.2	0.11-0.18	6.1-8.4	High---------	0.28			
Et----------------- Elmont	0-9	15-27	1.30-1.40	0.6-2.0	0.22-0.24	5.1-7.3	Low----------	0.32	5	6	2-4
	9-45	27-35	1.30-1.45	0.2-0.6	0.18-0.20	5.1-7.3	Moderate-----	0.43			
	45	---	---	---	---	---	-------------	----			
Ke, Kn------------ Kennebec	0-41	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	6	2-4
	41-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
Kp----------------- Kipson	0-9	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.32	2	4L	---
	9-19	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	Moderate-----	0.32			
	19	---	---	---	---	---	-------------	----			
Mb----------------- Morrill	0-10	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	Low----------	0.28	5	6	1-4
	10-60	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.28			
Me----------------- Morrill	0-6	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	Low----------	0.28	5	6	1-4
	6-60	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.28			
Om----------------- Olmitz	0-25	24-30	1.40-1.45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	3-4
	25-60	28-34	1.45-1.55	0.6-2.0	0.15-0.17	5.1-6.5	Moderate-----	0.28			
Pa, Pb------------ Pawnee	0-15	30-38	1.40-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate-----	0.37	4	6	3-4
	15-51	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	High---------	0.37			
	51-60	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	High---------	0.37			
Pe----------------- Pawnee	0-6	40-46	1.40-1.50	0.06-0.2	0.09-0.11	5.6-7.3	High---------	0.37	3	4	2-3
	6-40	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	High---------	0.37			
	40-60	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	High---------	0.37			
Pt*. Pits											
Re----------------- Reading	0-16	18-27	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	2-4
	16-49	27-35	1.40-1.50	0.2-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	49-60	30-42	1.40-1.50	0.2-2.0	0.13-0.20	6.1-8.4	Moderate-----	0.43			
Sb----------------- Sibleyville	0-9	14-29	1.30-1.40	0.6-2.0	0.18-0.21	5.6-7.3	Low----------	0.28	4	6	1-4
	9-23	20-35	1.35-1.45	0.6-2.0	0.16-0.19	5.1-7.3	Low----------	0.28			
	23-37	14-29	1.35-1.50	0.6-2.0	0.12-0.15	5.1-7.3	Low----------	0.28			
	37	---	---	---	---	---	-------------	----			
St----------------- Steinauer	0-6	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate-----	0.32	5	4L	.5-2
	6-60	16-30	1.30-1.60	0.2-2.0	0.14-0.19	7.9-8.4	Moderate-----	0.32			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
Vv: Vinland Variant	0-8	12-18	1.30-1.40	0.6-2.0	0.22-0.24	5.6-7.8	Low	0.32	4	7	---
	8-29	12-18	1.35-1.45	0.6-2.0	0.19-0.22	5.6-7.8	Low	0.32			
	29	---	---	---	---	---	-------------	----			
Wa: Wabash	0-12	20-35	1.35-1.50	0.06-0.2	0.21-0.24	5.6-7.3	High	0.28	5	4	2-4
	12-60	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	Very high	0.28			
Wb, Wc: Wymore	0-6	30-40	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	Moderate	0.37	4	7	2-4
	6-41	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	High	0.37			
	41-60	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.8	High	0.37			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Bf----------------- Benfield	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High------	Low.
Bs*:												
Burchard-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Steinauer----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
Cc----------------- Calco	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
Ch----------------- Chase	C	Occasional	Very brief	Mar-Sep	2.0-4.0	Perched	Feb-May	>60	---	High------	High------	Low.
Et----------------- Elmont	B	None---------	---	---	>6.0	---	---	40-60	Soft	High------	Moderate	Low.
Ke----------------- Kennebec	B	Occasional	Brief-----	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	High------	Moderate	Low.
Kn----------------- Kennebec	B	Frequent----	Brief-----	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	High------	Moderate	Low.
Kp----------------- Kipson	D	None---------	---	---	>6.0	---	---	7-20	Soft	Moderate	Low-------	Low.
Mb, Me------------- Morrill	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Om----------------- Olmitz	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Pa, Pb, Pe--------- Pawnee	D	None---------	---	---	1.0-3.0	Perched	Mar-May	>60	---	High------	High------	Low.
Pt*. Pits												
Re----------------- Reading	C	Rare---------	---	---	>6.0	---	---	>60	---	High------	Moderate	Low.
Sb----------------- Sibleyville	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low-------	Moderate.
St----------------- Steinauer	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
Vv----------------- Vinland Variant	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Moderate	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Wa----------------- Wabash	D	Occasional	Brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	Moderate	High-----	Moderate.
Wb, Wc------------- Wymore	D	None---------	---	---	1.0-3.0	Perched	Mar-Apr	>60	---	High-----	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution*							Liquid limit	Plasticity index	Moisture density**	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
										Pct		Lb/ft3	Pct
Steinauer clay loam:													
Ap------- 0 to 6	A-7-6(08)	CL	100	100	88	59	39	---	---	42	17	250	18
C1-------13 to 39	A-7-6(13)	CL	100	100	90	69	49	---	---	42	21	437	18
C2-------39 to 60	A-7-6(16)	CL	100	100	92	72	57	---	---	43	24	--	17
Wymore silty clay loam:													
Ap------- 0 to 6	A-6(13)	ML	100	100	99	97	70	---	---	37	12	375	22
B21t----- 9 to 20	A-7-6(49)	CH	100	100	100	98	85	---	---	70	42	562	27
C---------41 to 60	A-7-6(26)	CL	100	100	100	98	76	---	---	47	24	437	22

* Grain-size distribution according to the AASHTO Designation T 88 72 with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher; (2) the sample is not soaked prior to dispersion; (3) dispersing time is 5 minutes at 7 p.s.i. using an Iowa air tube; and (4) AASHTO T 133 74 is followed except for sample size to obtain SpG for the hydrometer analysis. Results by this procedure frequently differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes.

** Moisture density based on AASHTO Designation T 99 74, Method A, with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher after drying, and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

TABLE 19.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Benfield	Fine, mixed, mesic Udic Argiustolls
Burchard	Fine-loamy, mixed, mesic Typic Argiudolls
Calco*	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Chase	Fine, montmorillonitic, mesic Aquic Argiudolls
Elmont	Fine-silty, mixed, mesic Typic Argiudolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Reading	Fine-silty, mixed, mesic Typic Argiudolls
Sibleyville	Fine-loamy, mixed, mesic Typic Argiudolls
Steinauer	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Vinland Variant	Coarse-silty, mixed, mesic Typic Hapludolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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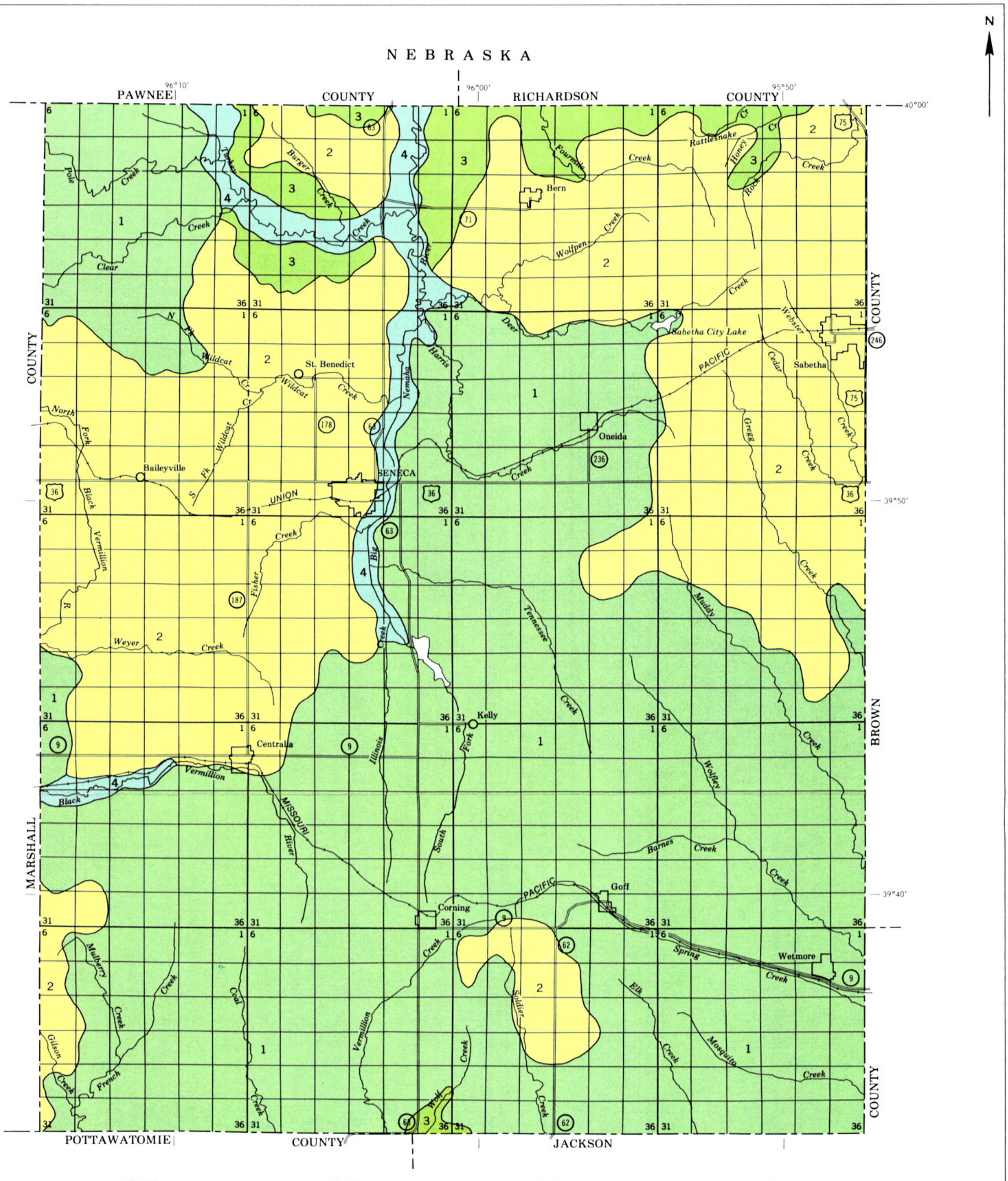


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
NEMAHA COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SOIL LEGEND

1 — Pawnee-Burchard-Steinauer association: Deep, gently sloping to moderately steep, moderately well drained or well drained soils that have a loamy or clayey subsoil; on uplands

2 — Wymore-Pawnee association: Deep, gently sloping or moderately sloping, moderately well drained soils that have a dominantly clayey subsoil; on uplands

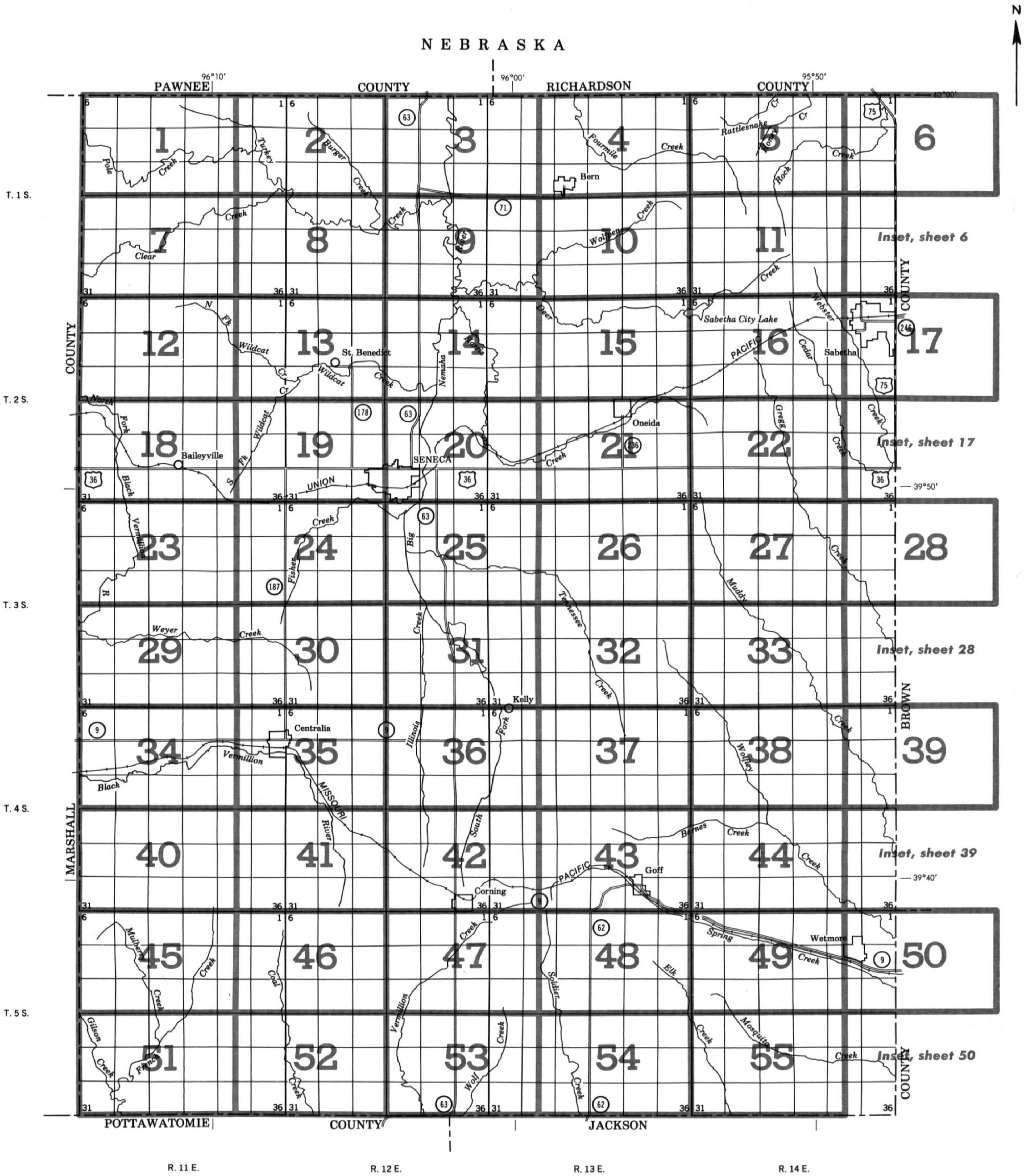
3 — Kipson-Pawnee-Wymore association: Shallow or deep, gently sloping to moderately steep, somewhat excessively drained or moderately well drained soils that have a silty, loamy, or clayey subsoil; on uplands

4 — Kennebec-Wabash-Chase association: Deep, nearly level, moderately well drained, very poorly drained, or somewhat poorly drained soils that have a silty or clayey subsoil; on flood plains or terraces

Compiled 1981

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

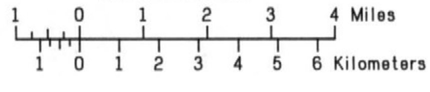


Original text from each individual map sheet read:
This soil survey is compiled on 1977 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS

NEMAHA COUNTY, KANSAS

Scale 1:190,080



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Bf	Benfield silty clay loam, 5 to 9 percent slopes
Bs	Burchard-Steinauer clay loams, 6 to 12 percent slopes
Cc	Calco silty clay loam
Ch	Chase silty clay loam
Et	Elmont silt loam, 3 to 7 percent slopes
Ke	Kennebec silt loam
Kn	Kennebec silt loam, channeled
Kp	Kipson silty clay loam, 5 to 25 percent slopes
Mb	Morrill loam, 4 to 8 percent slopes
Me	Morrill clay loam, 4 to 8 percent slopes, eroded
Om	Olmitz loam, 1 to 5 percent slopes
Pa	Pawnee clay loam, 1 to 4 percent slopes
Pb	Pawnee clay loam, 4 to 8 percent slopes
Pe	Pawnee clay, 4 to 8 percent slopes, eroded
Pt	Pits, quarries
Re	Reading silt loam
Sb	Sibleyville loam, 4 to 8 percent slopes
St	Steinauer clay loam, 12 to 25 percent slopes
Vv	Vinland Variant loam, 5 to 25 percent slopes
Wa	Wabash silty clay loam
Wb	Wymore silty clay loam, 1 to 4 percent slopes
Wc	Wymore silty clay loam, 4 to 8 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — Wa Ch

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

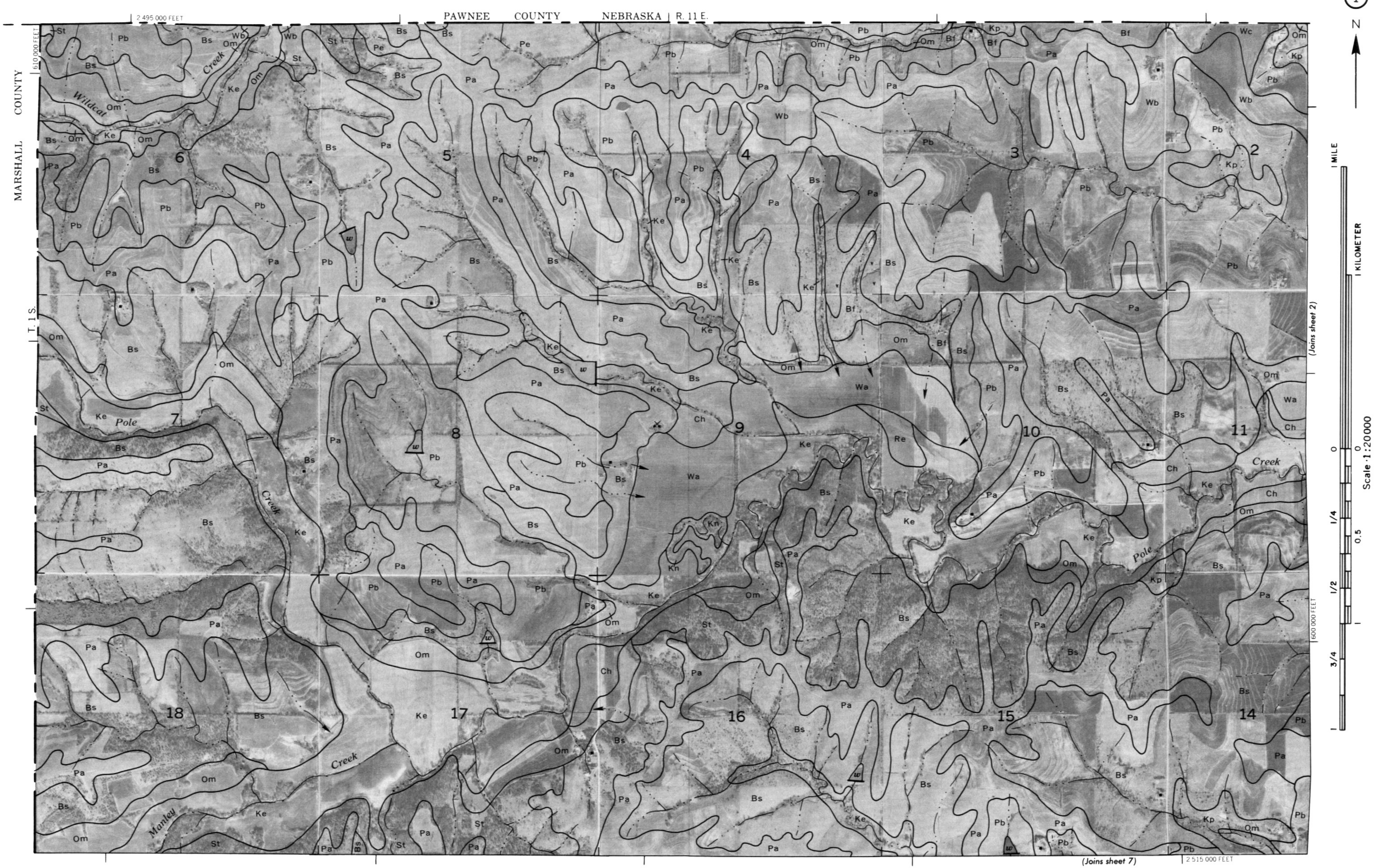
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

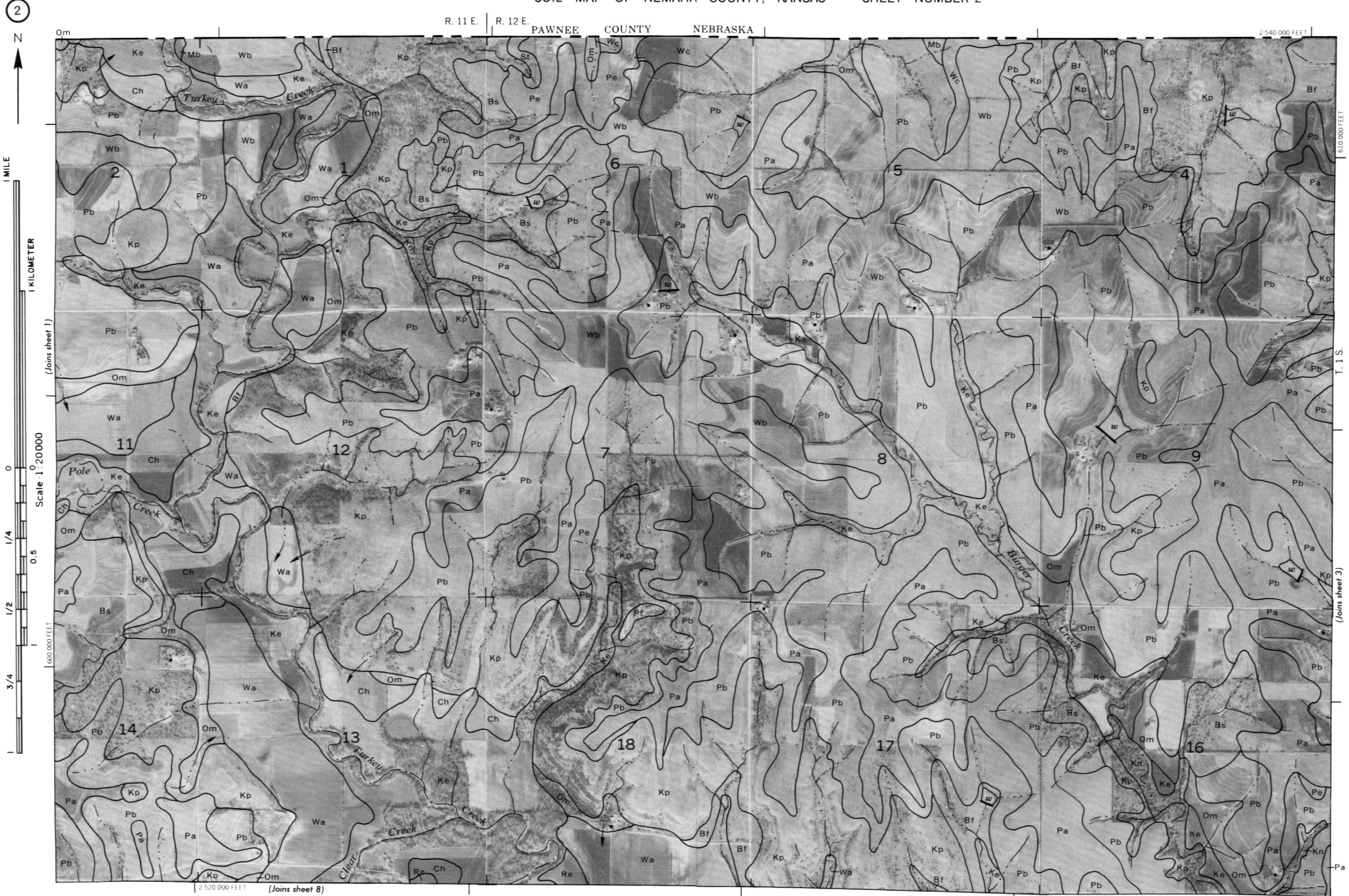
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 1

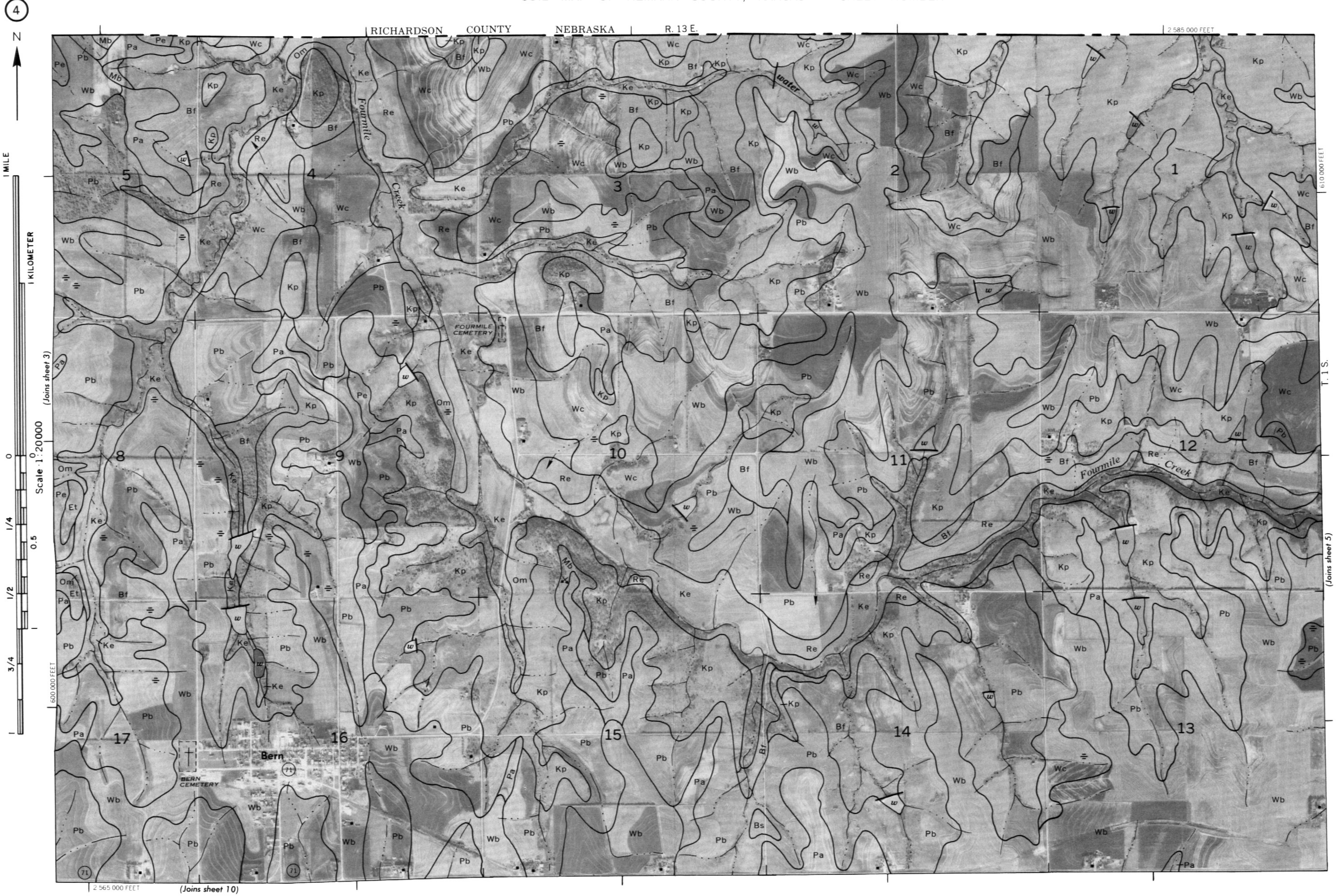


SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 2



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 3

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 4



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 5

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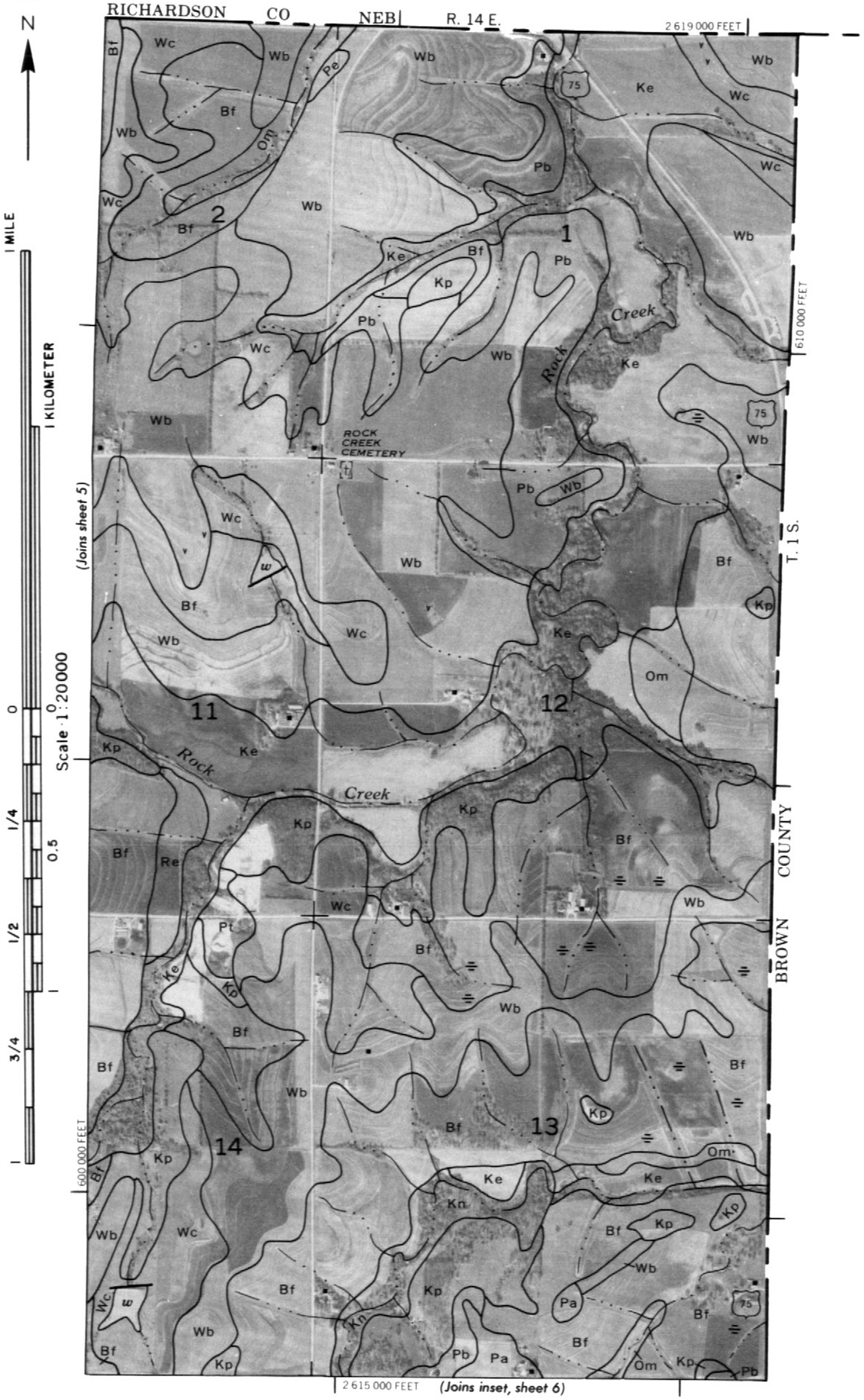
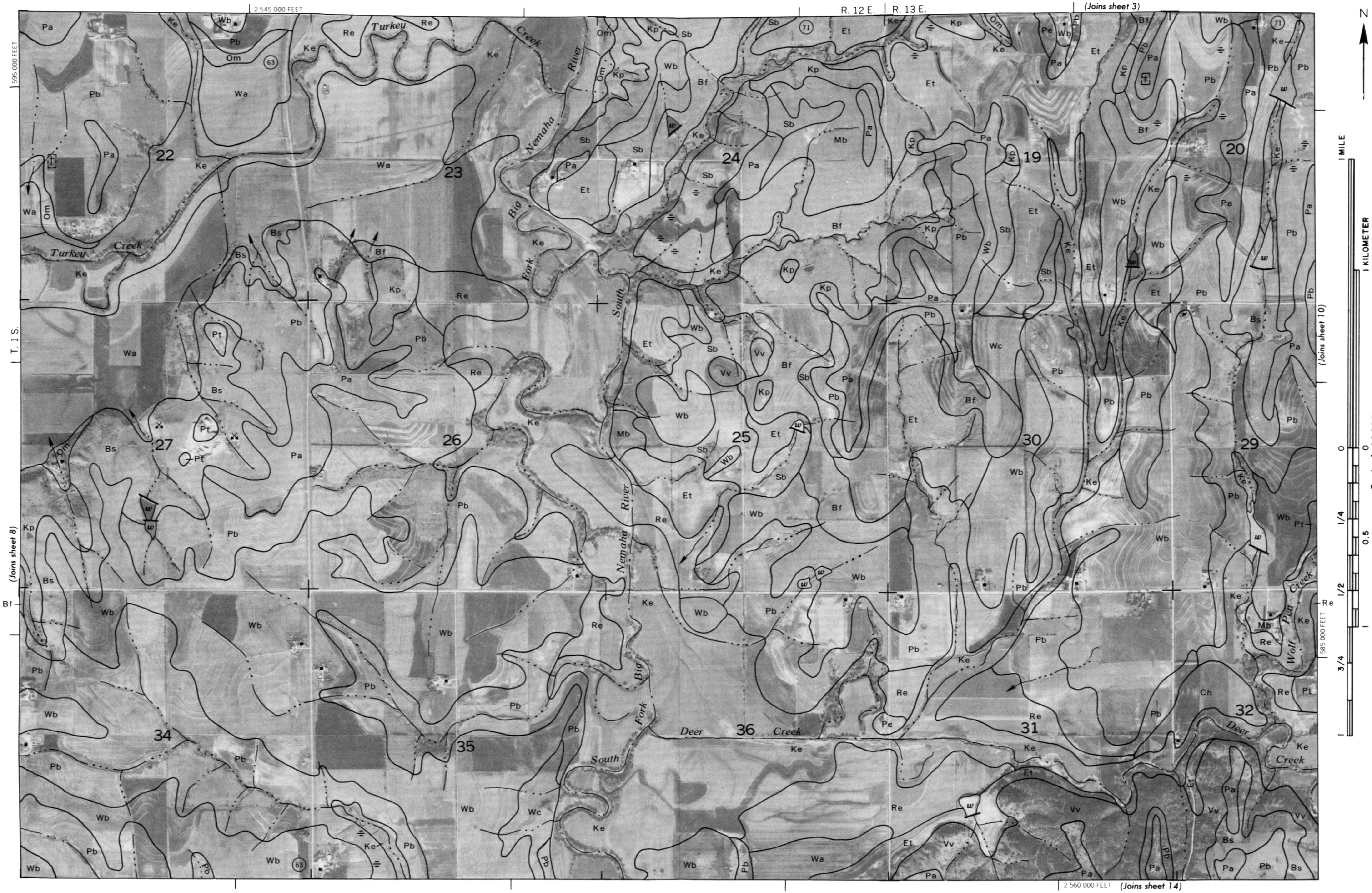
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 6



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 7

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 8

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 9



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 10

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 11

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 12

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 13

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 14

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 15

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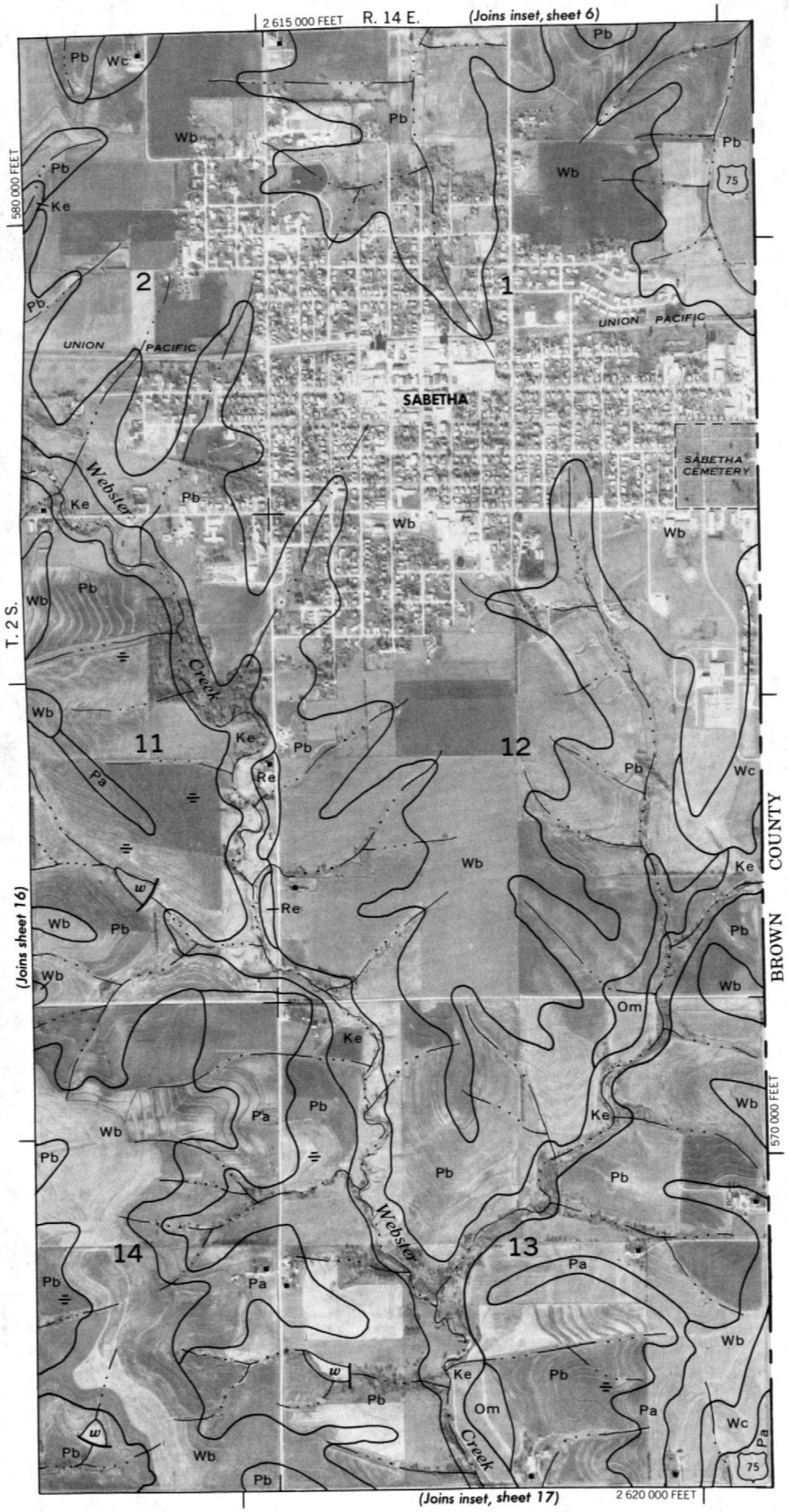
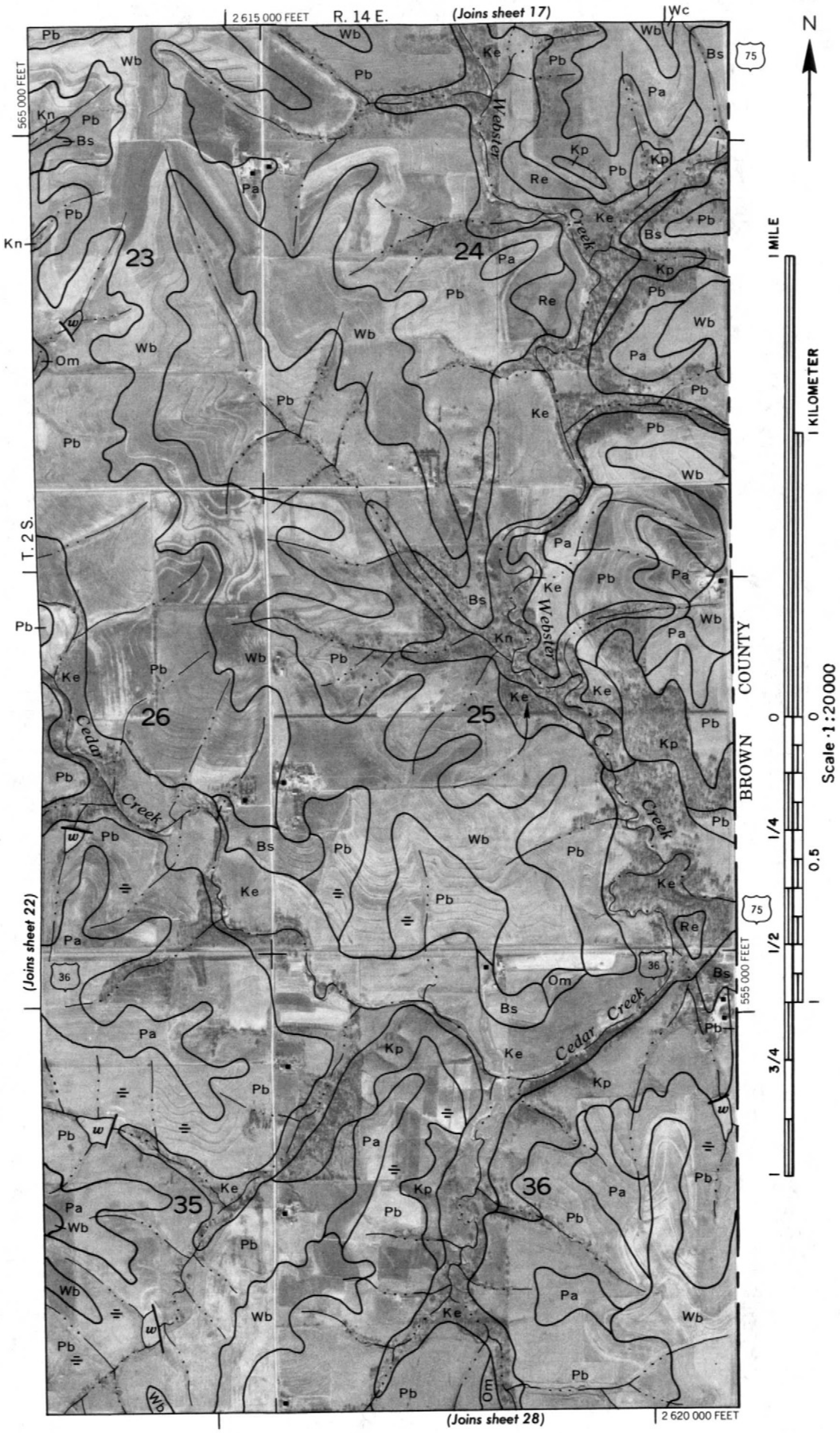
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 16

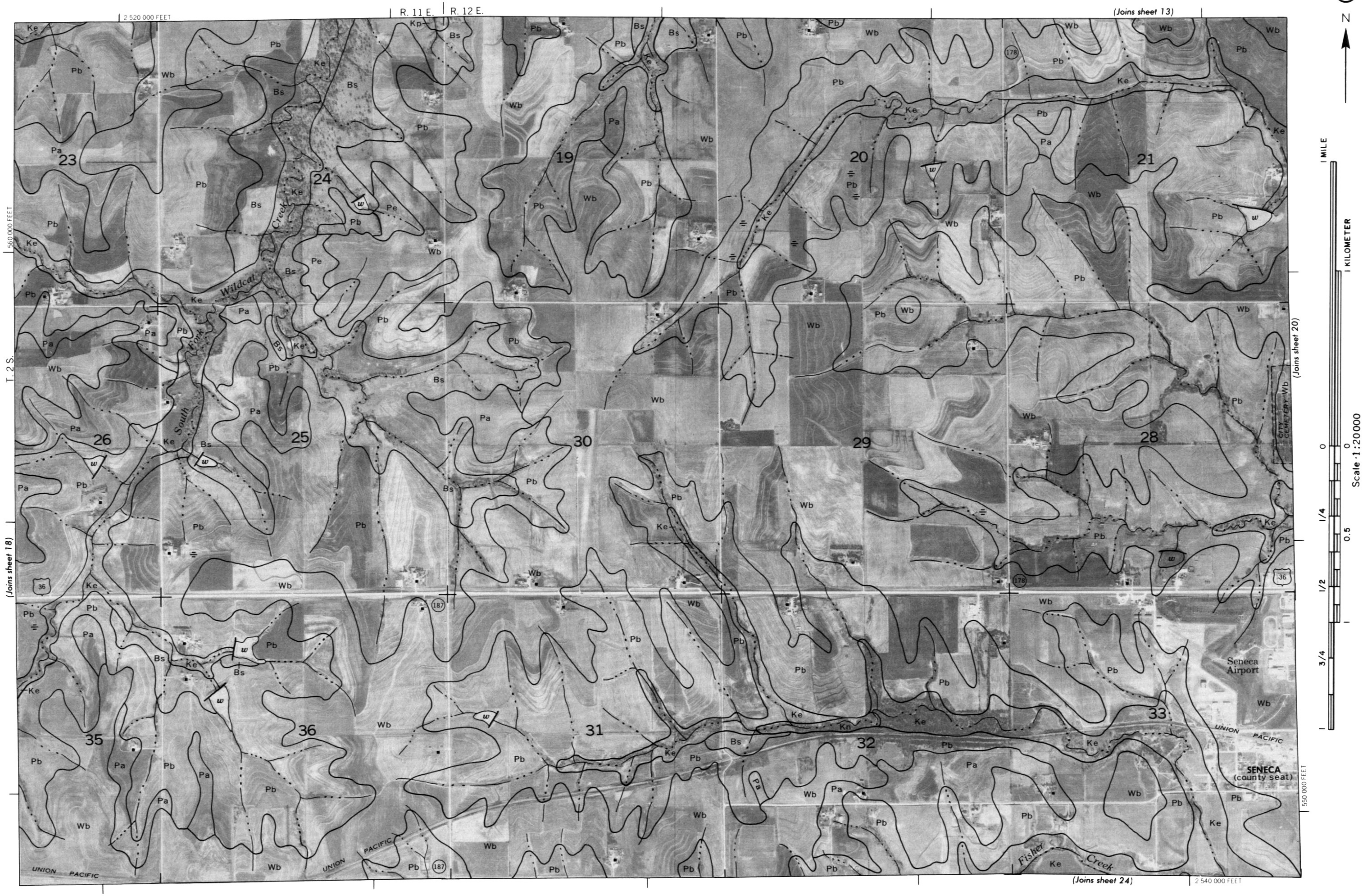

2 615 000 FEET
R. 14 E.
(Joins inset, sheet 6)
580 000 FEET
T. 2 S.
(Joins sheet 16)
SABETHA
UNION PACIFIC
SABETHA CEMETERY
Webster Creek
BROWN COUNTY
570 000 FEET
(Joins inset, sheet 17)
2 620 000 FEET
1
2
11
12
13
14


2 615 000 FEET
R. 14 E.
(Joins sheet 17)
565 000 FEET
T. 2 S.
(Joins sheet 22)
Webster Creek
Cedar Creek
BROWN COUNTY
555 000 FEET
(Joins sheet 28)
2 620 000 FEET
23
24
25
26
35
36
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000

(18)

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 18

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 19



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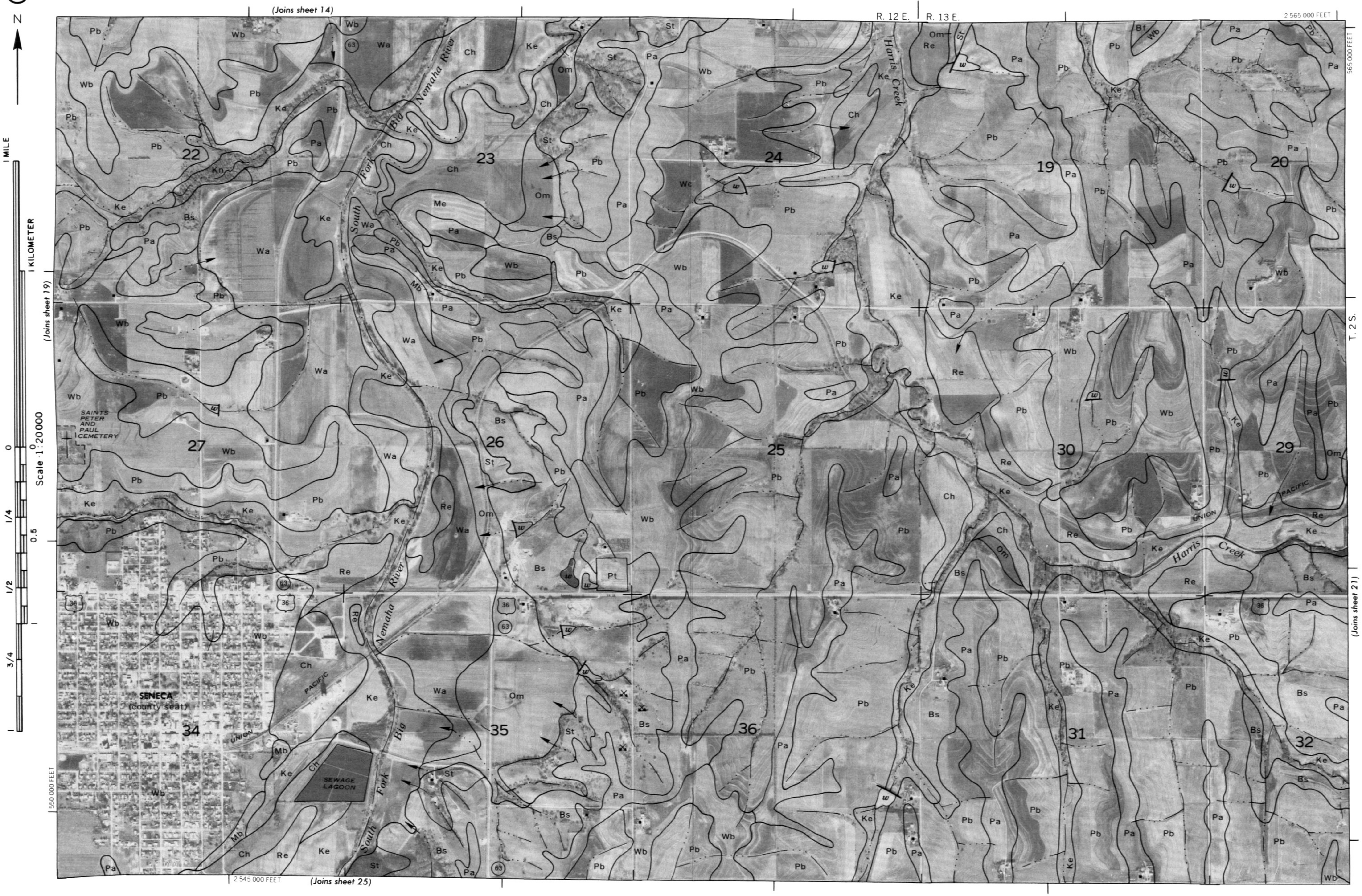
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 20



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 21

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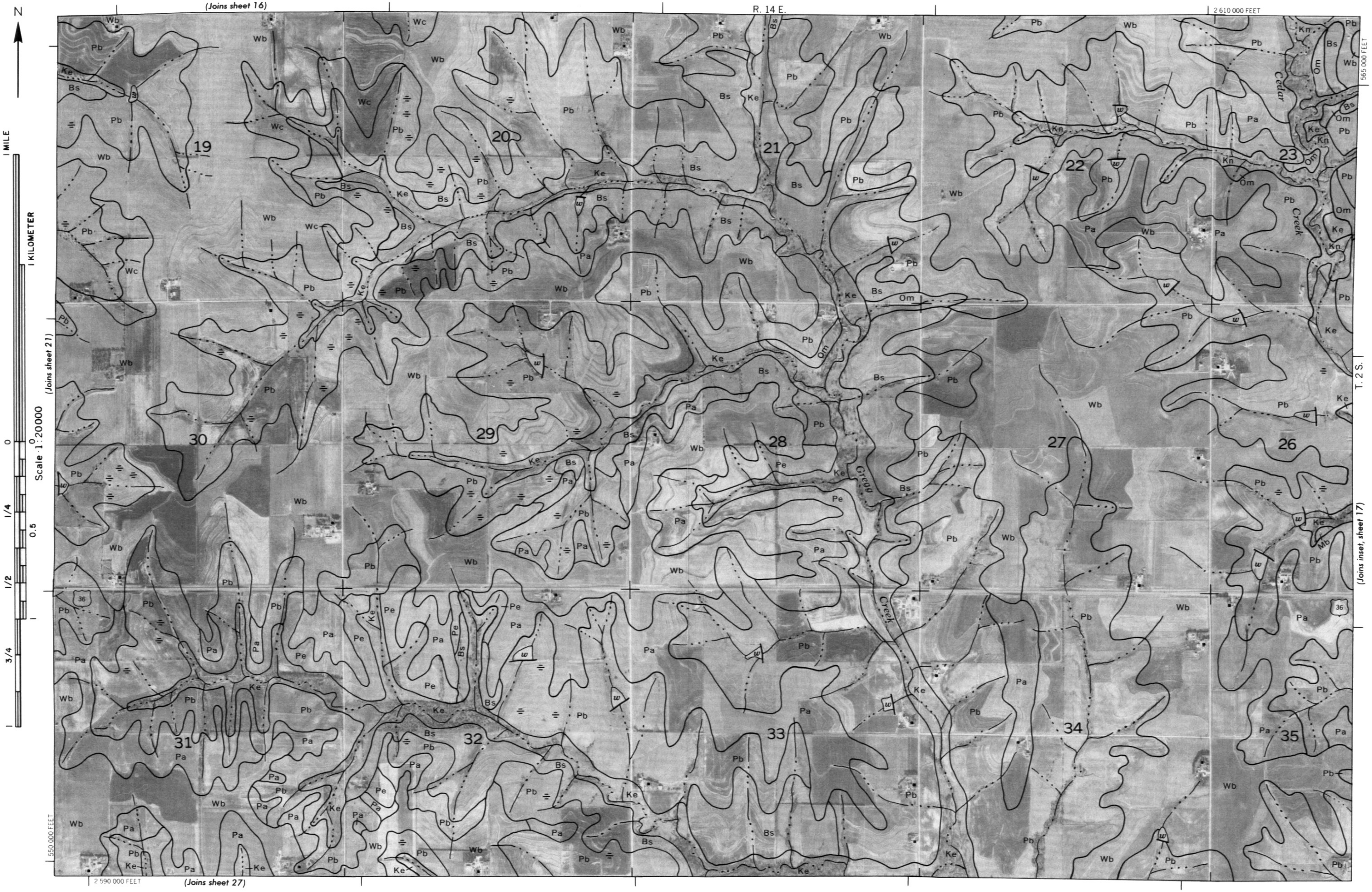
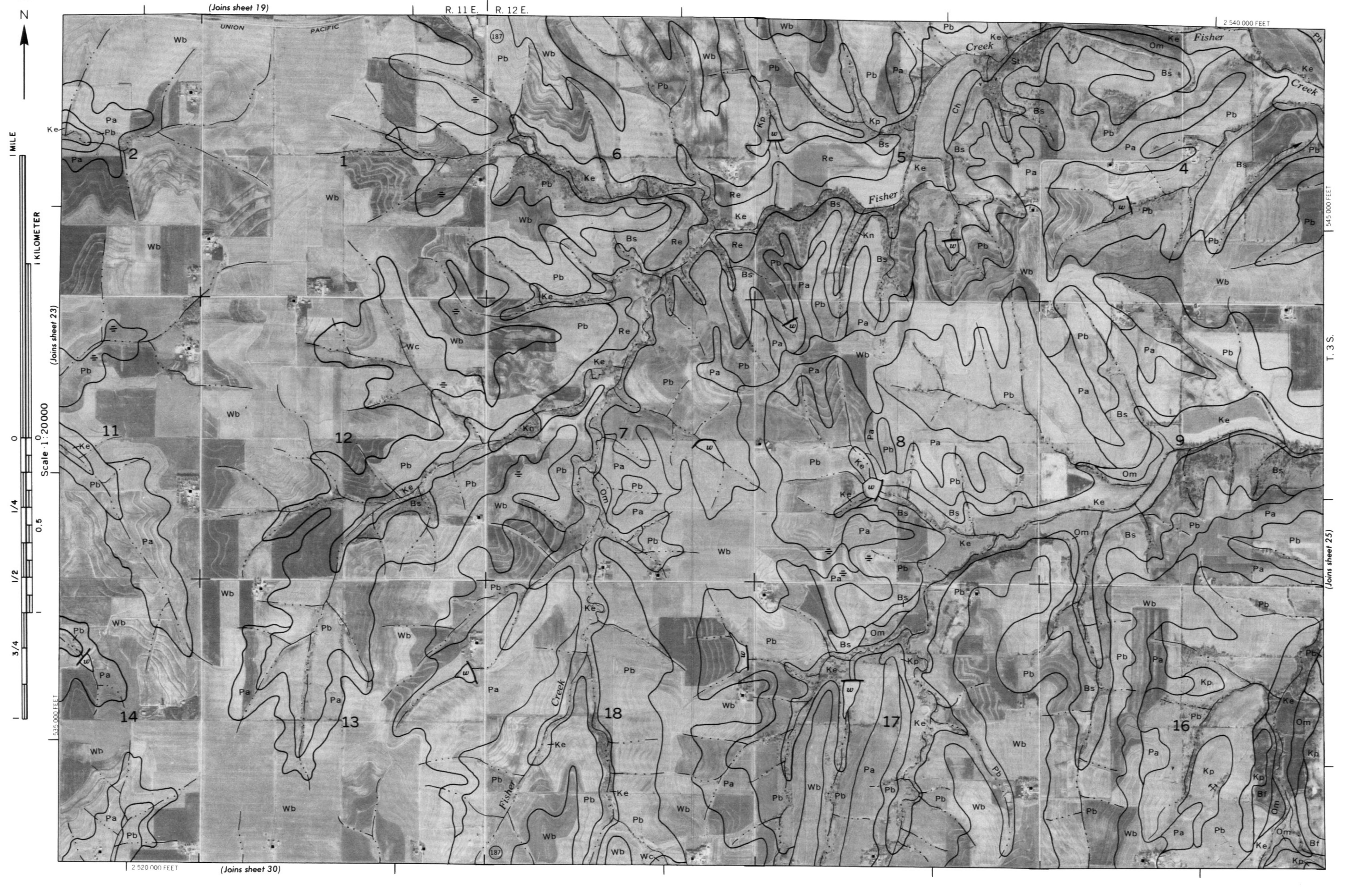
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 22



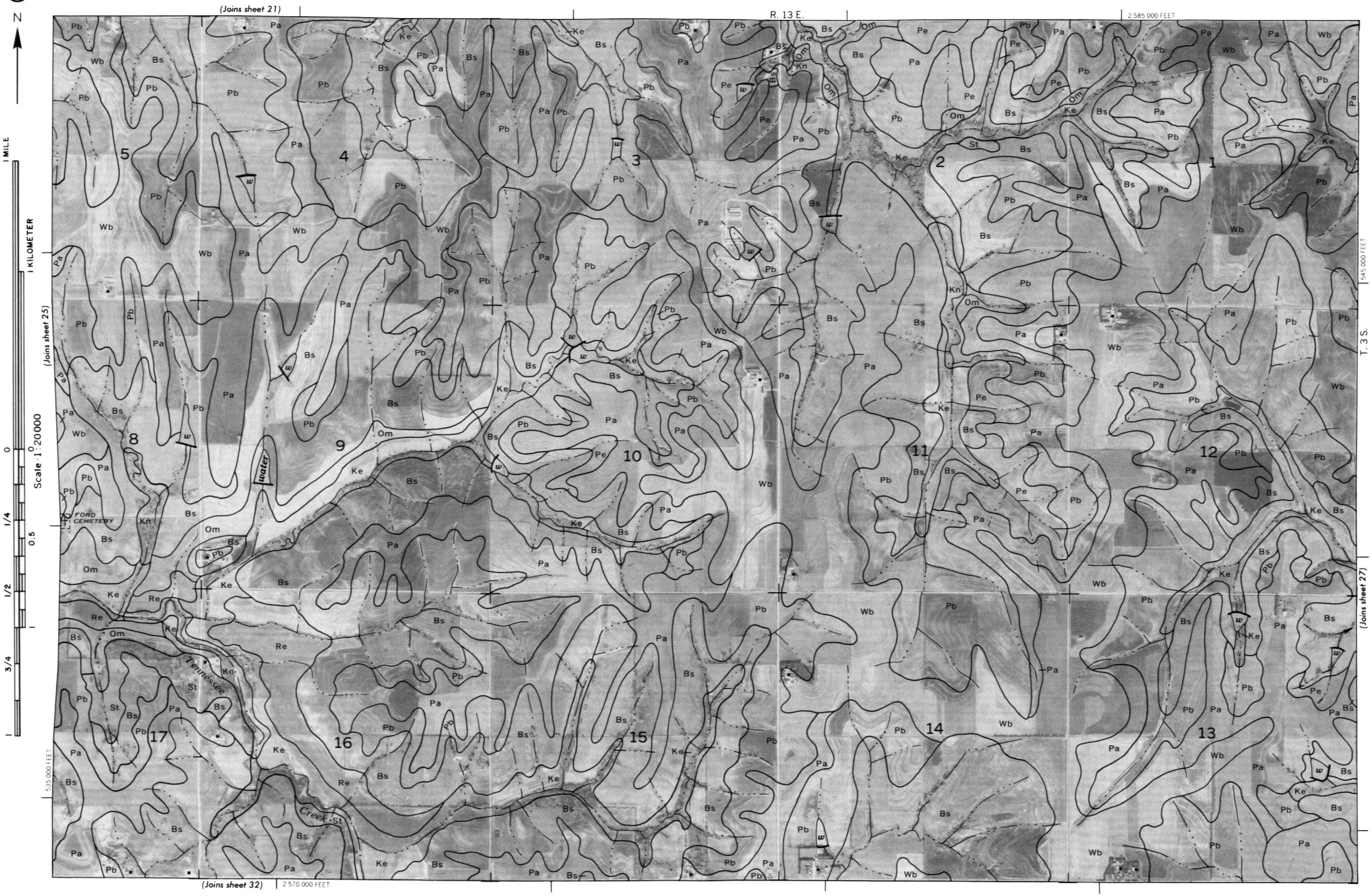

23
N
(Joins sheet 18)
R. 11 E.
2 495 000 FEET
545 000 FEET
T. 3 S.
MARSHALL COUNTY
(Joins sheet 24)
(Joins sheet 29)
2 515 000 FEET
535 000 FEET
Vermillion
River
Black
Fork
North
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 24



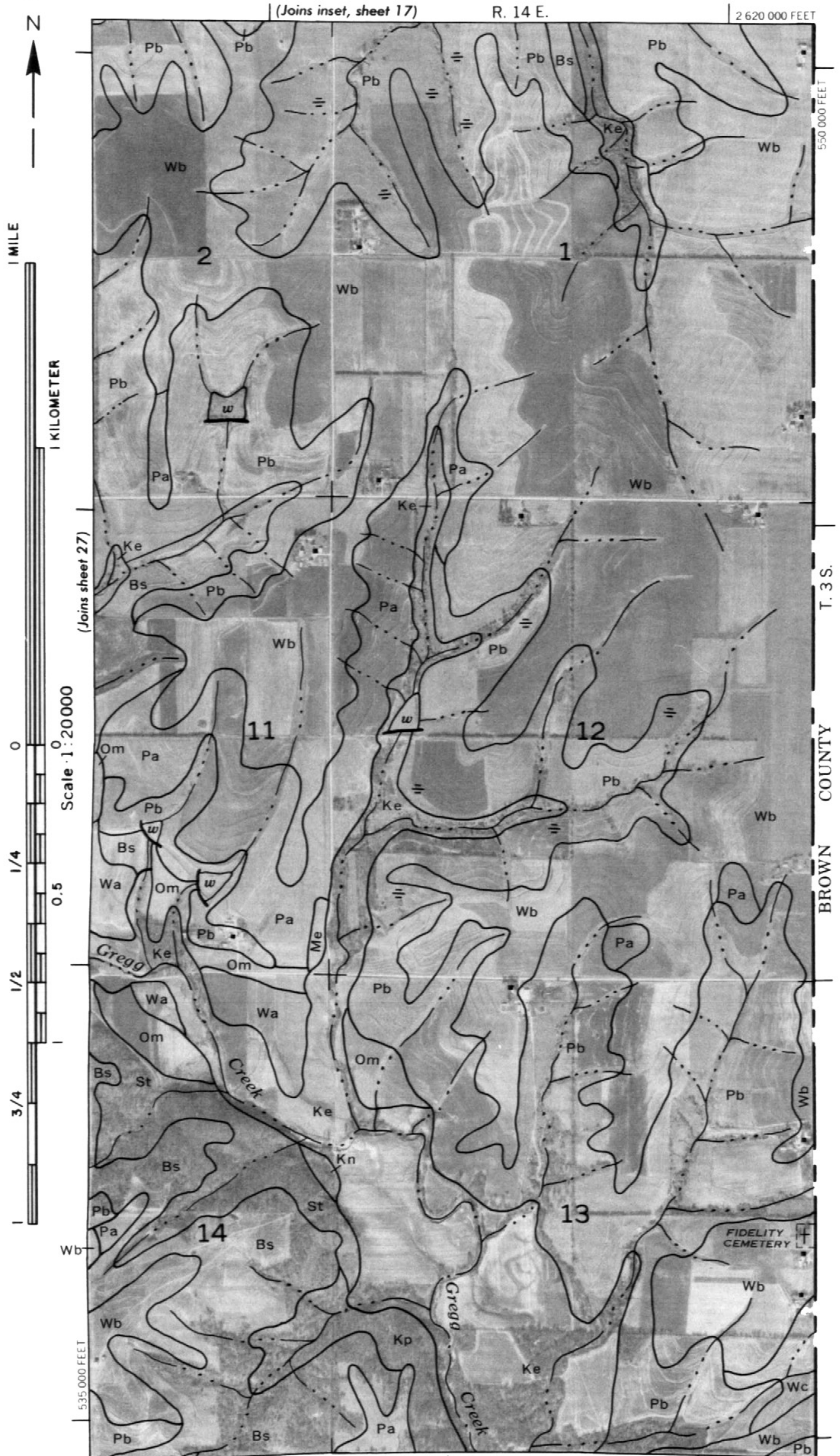
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 25

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 26

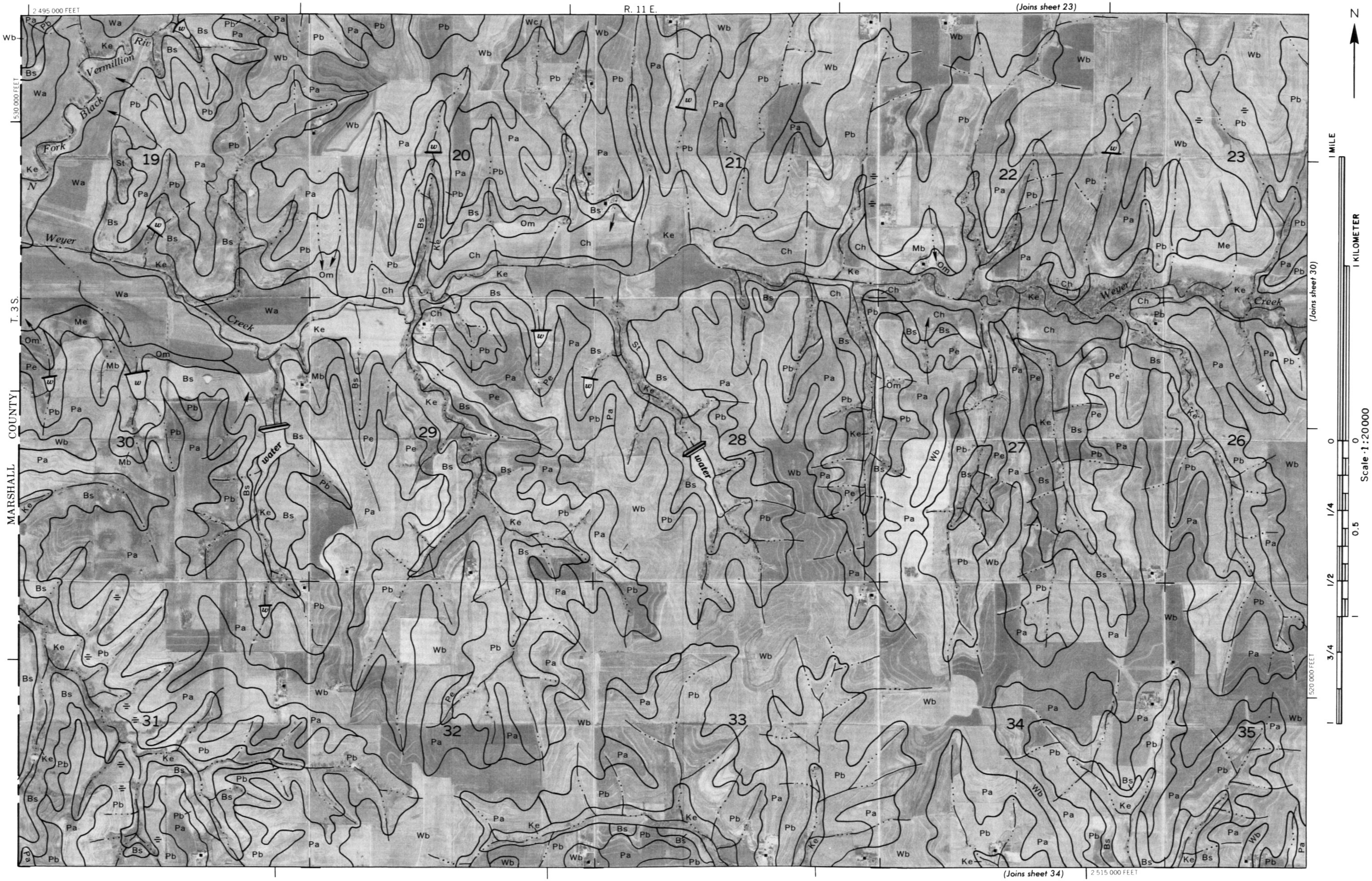


2 590 000 FEET
R. 14 E.
(Joins sheet 22)
N
T. 3 S.
545 000 FEET
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 33)
2 610 000 FEET
535 000 FEET
Gregg Creek
Muddy Creek
Woodlawn Cemetery
Woodlawn
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

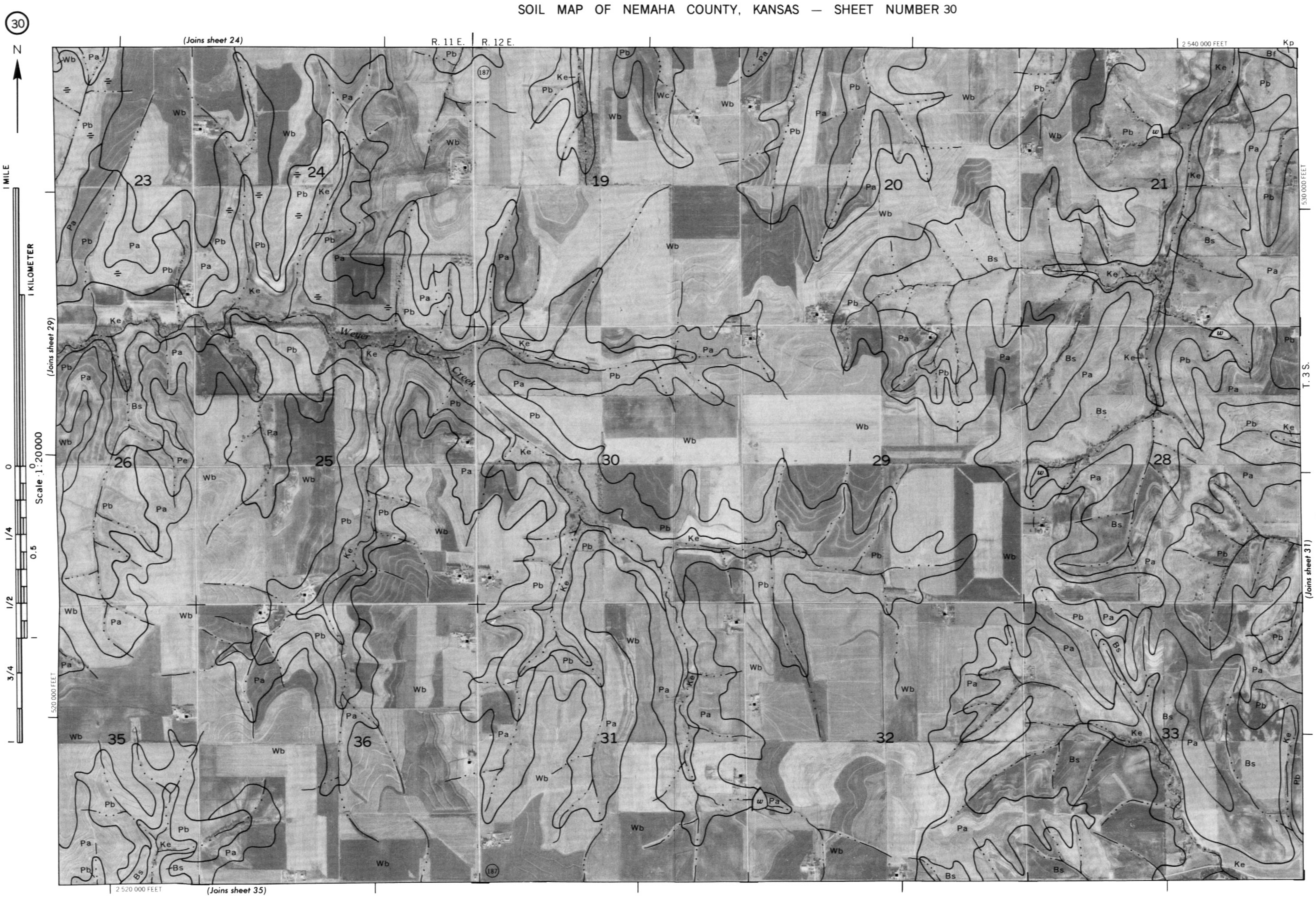
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 28



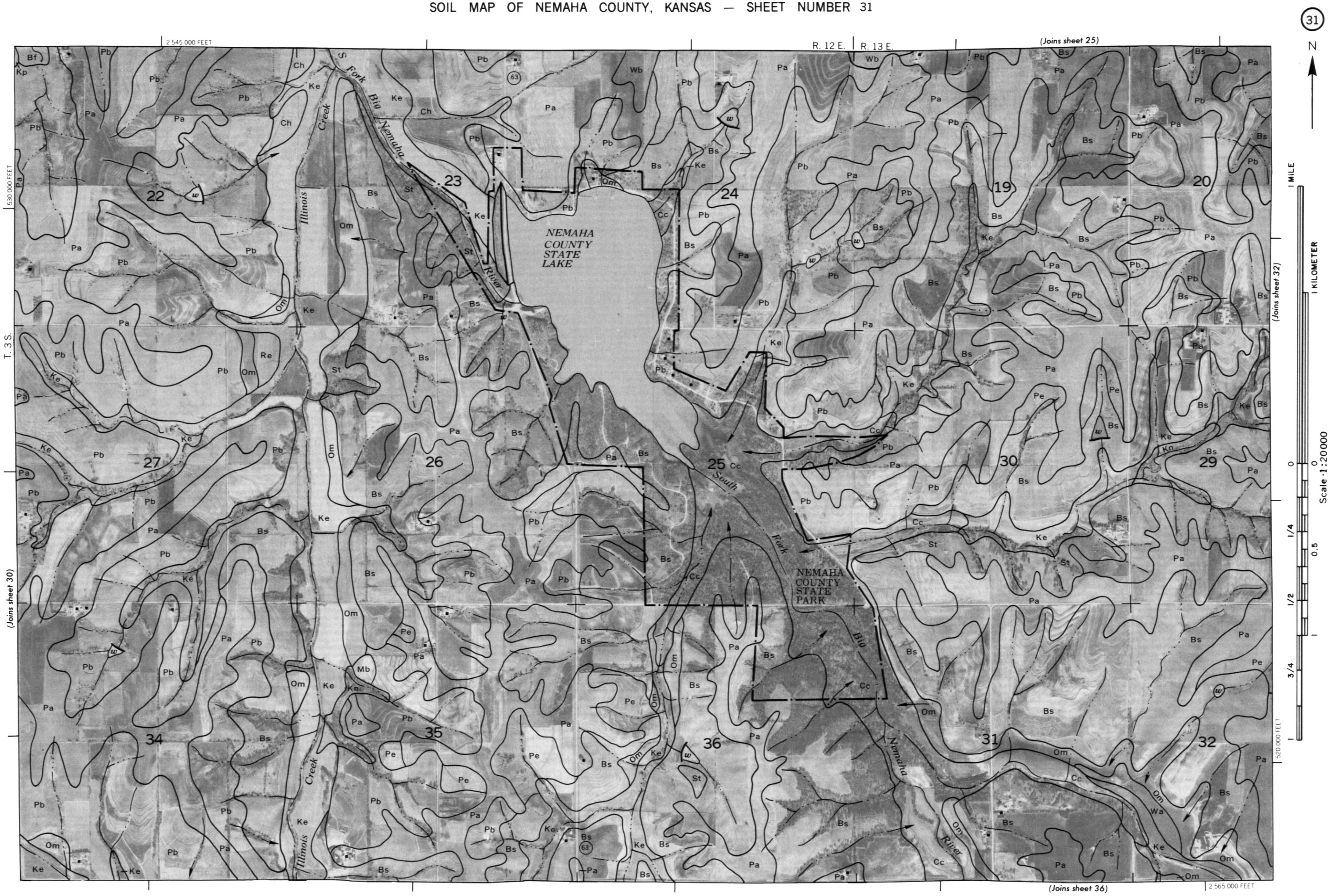
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 29



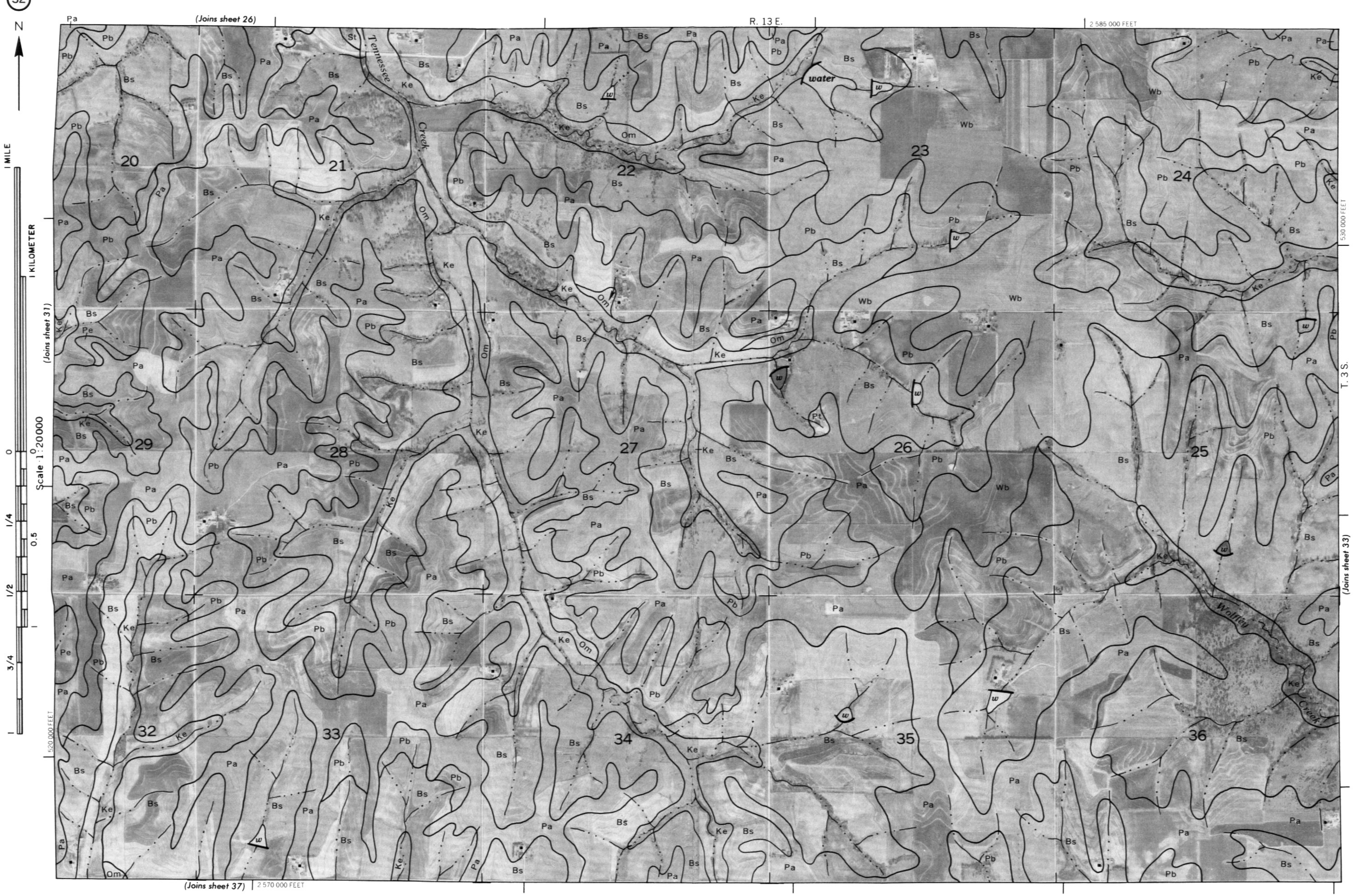
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 30



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 31

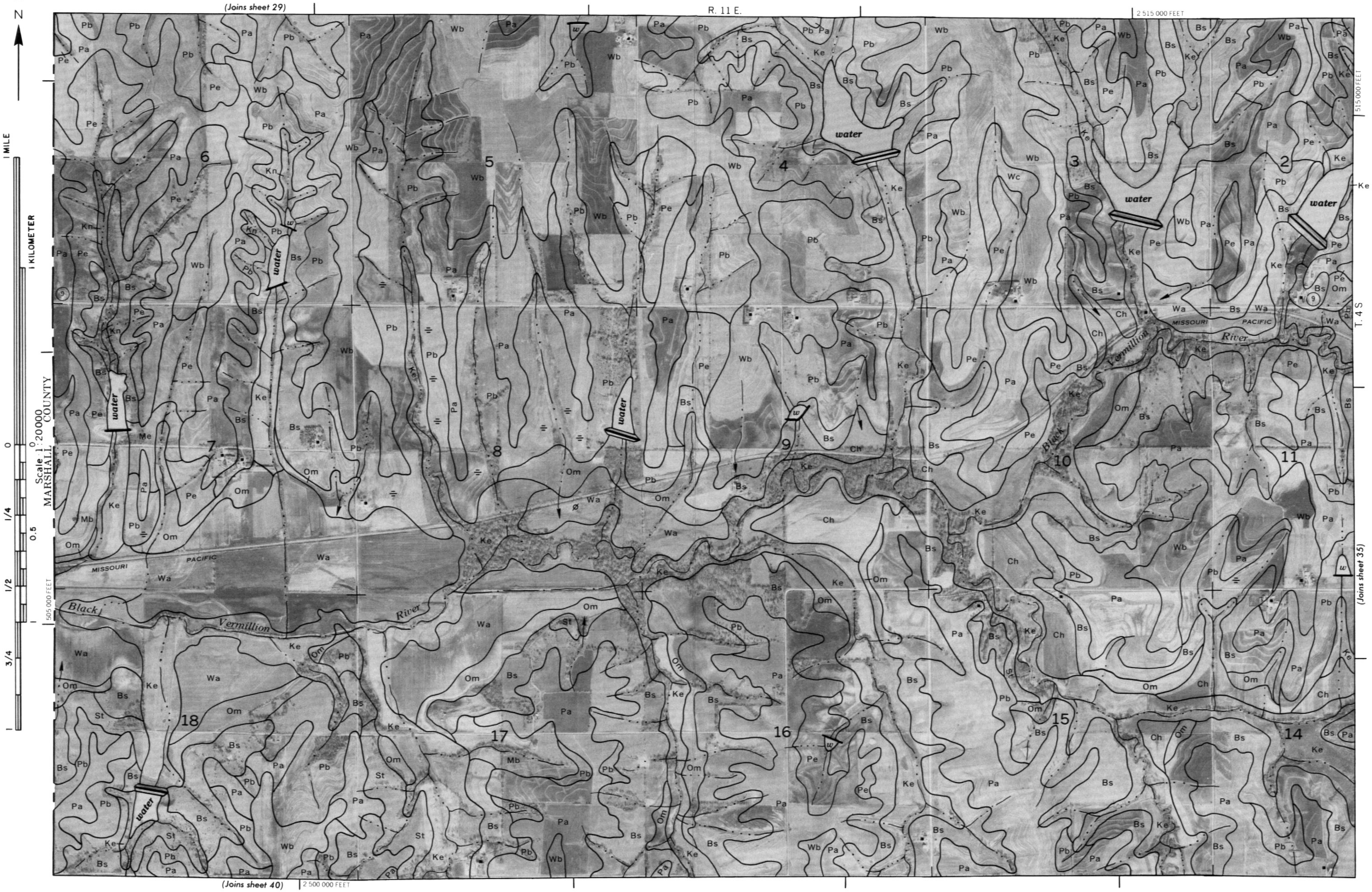


SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 32

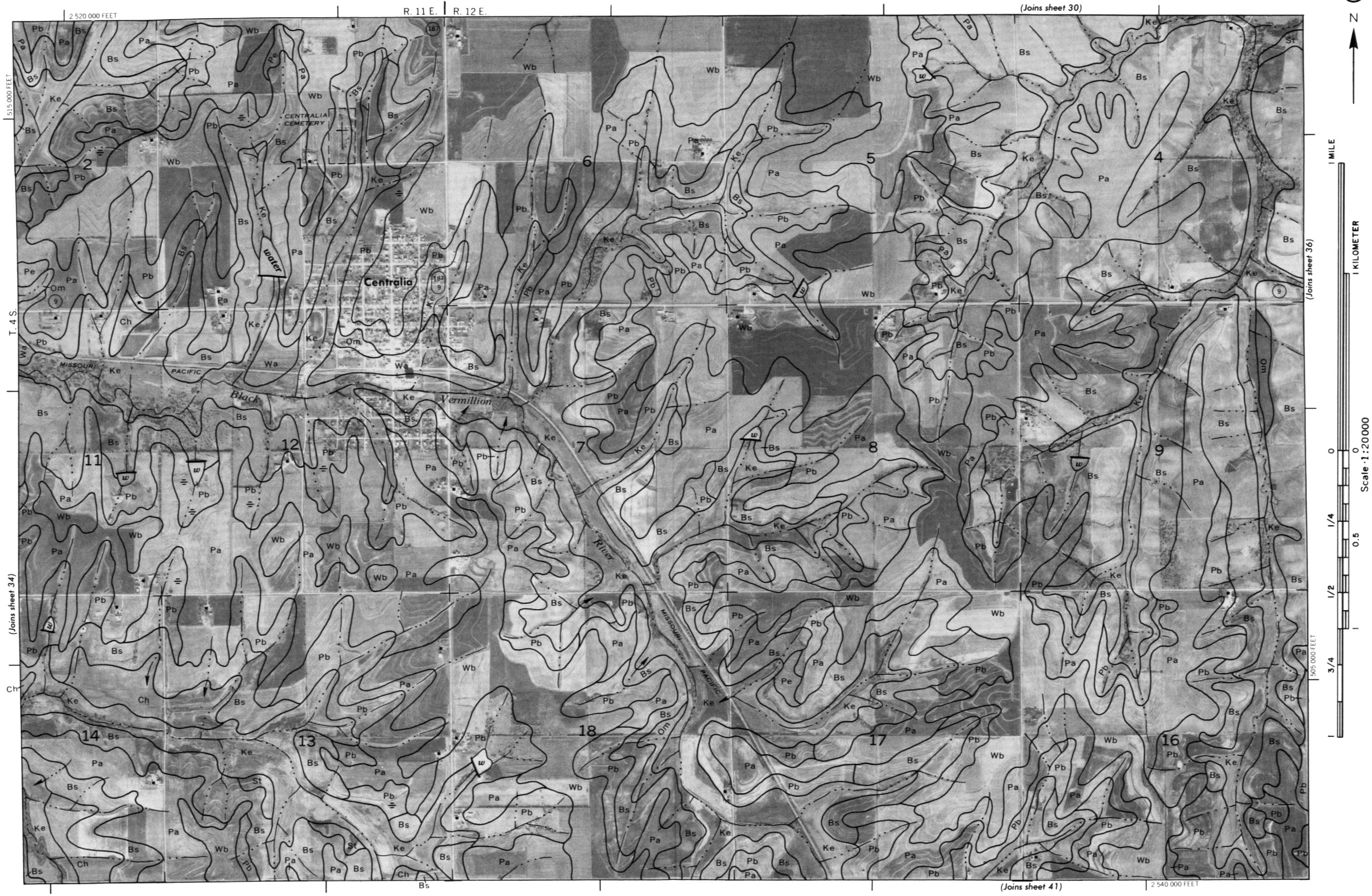


SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 33

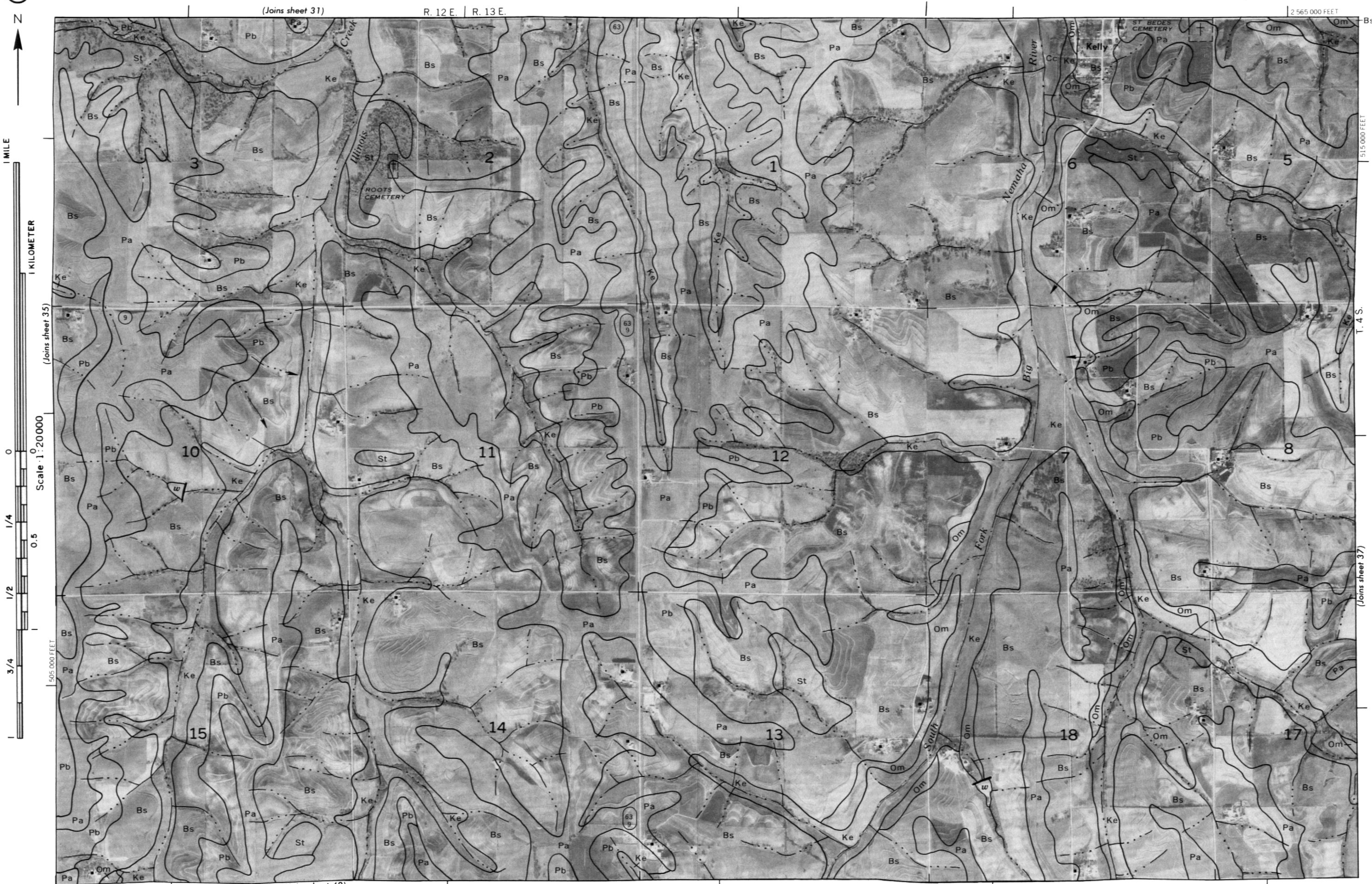
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 34



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 35



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 36

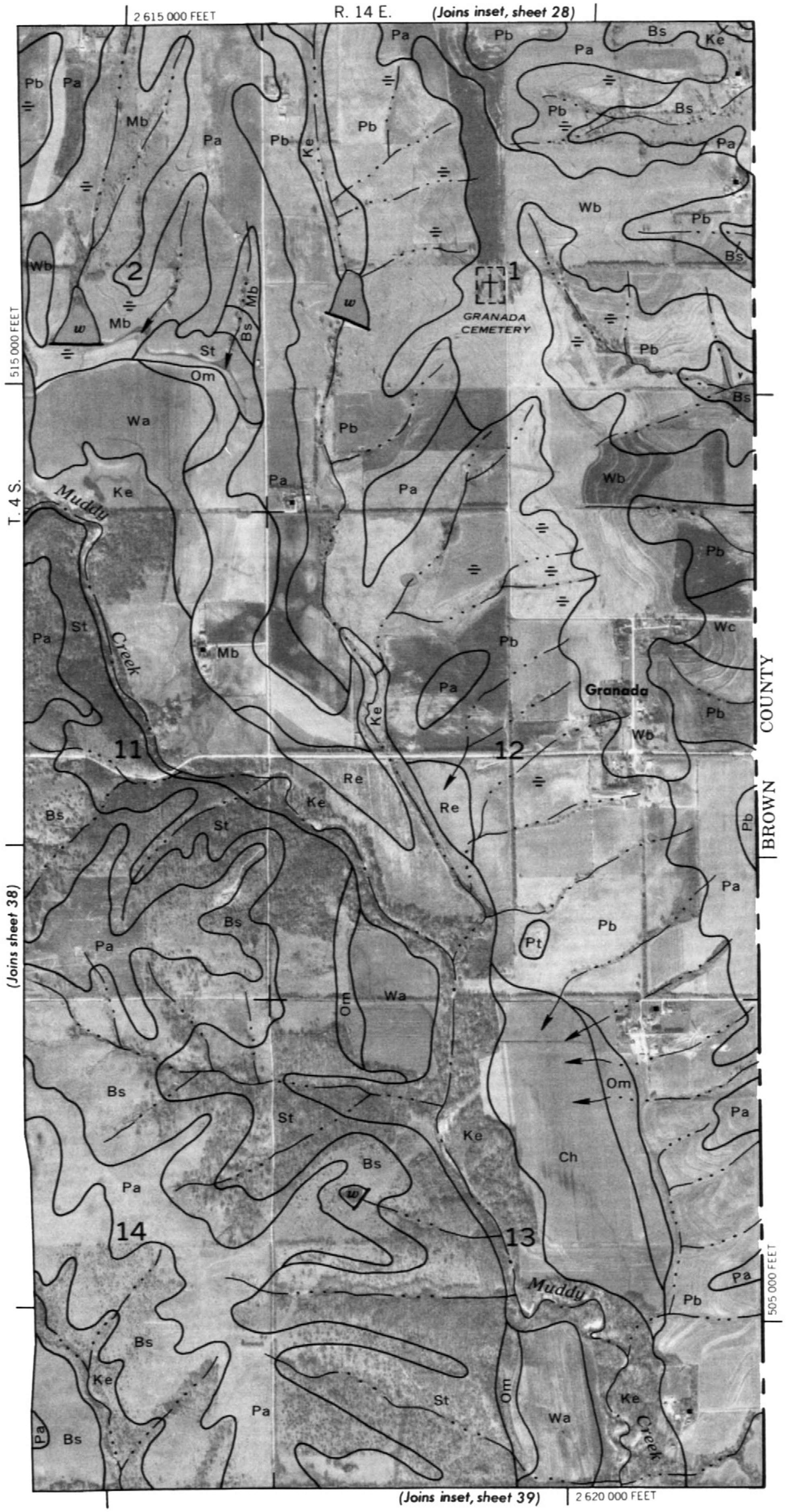


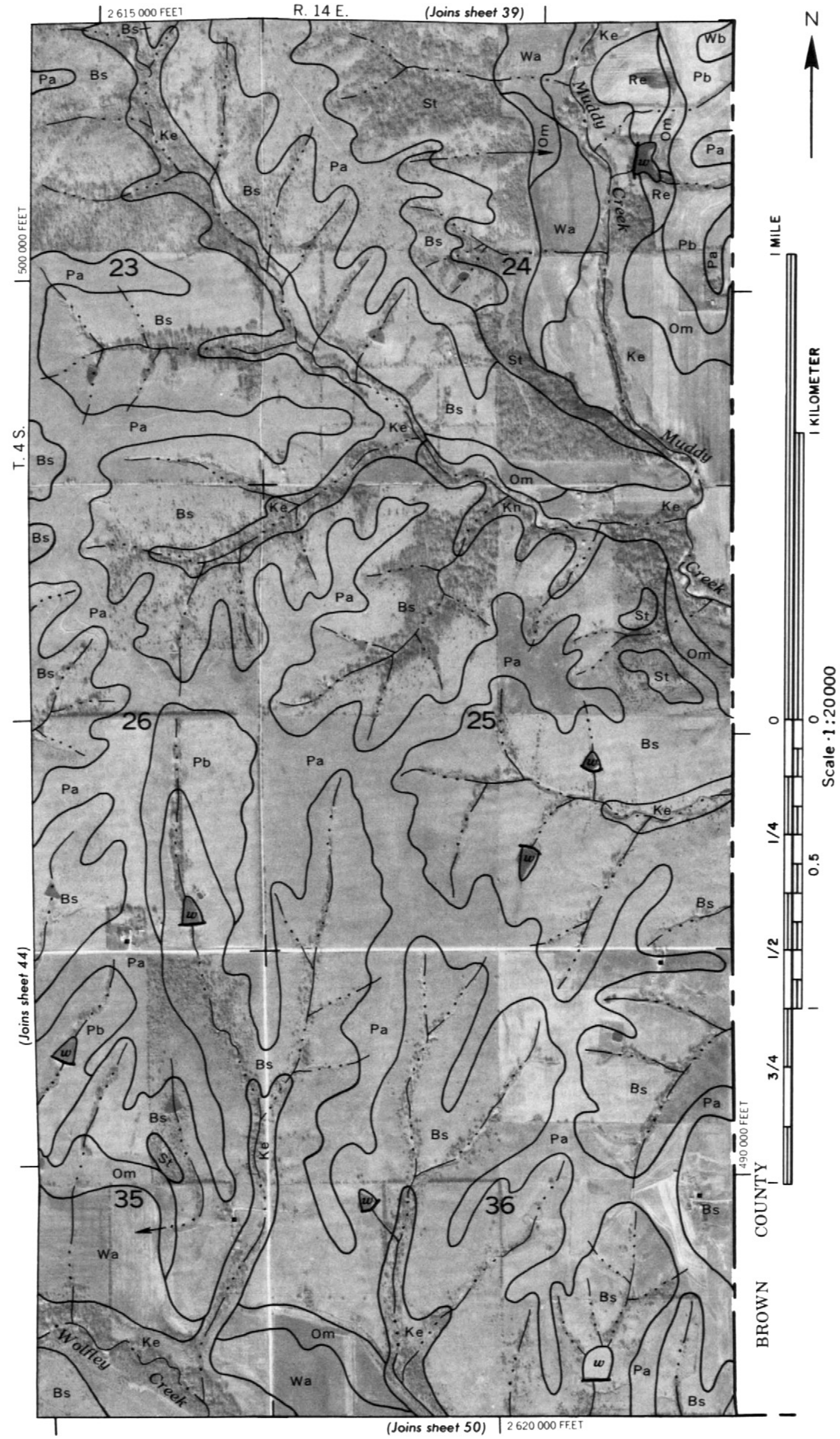
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 37

38

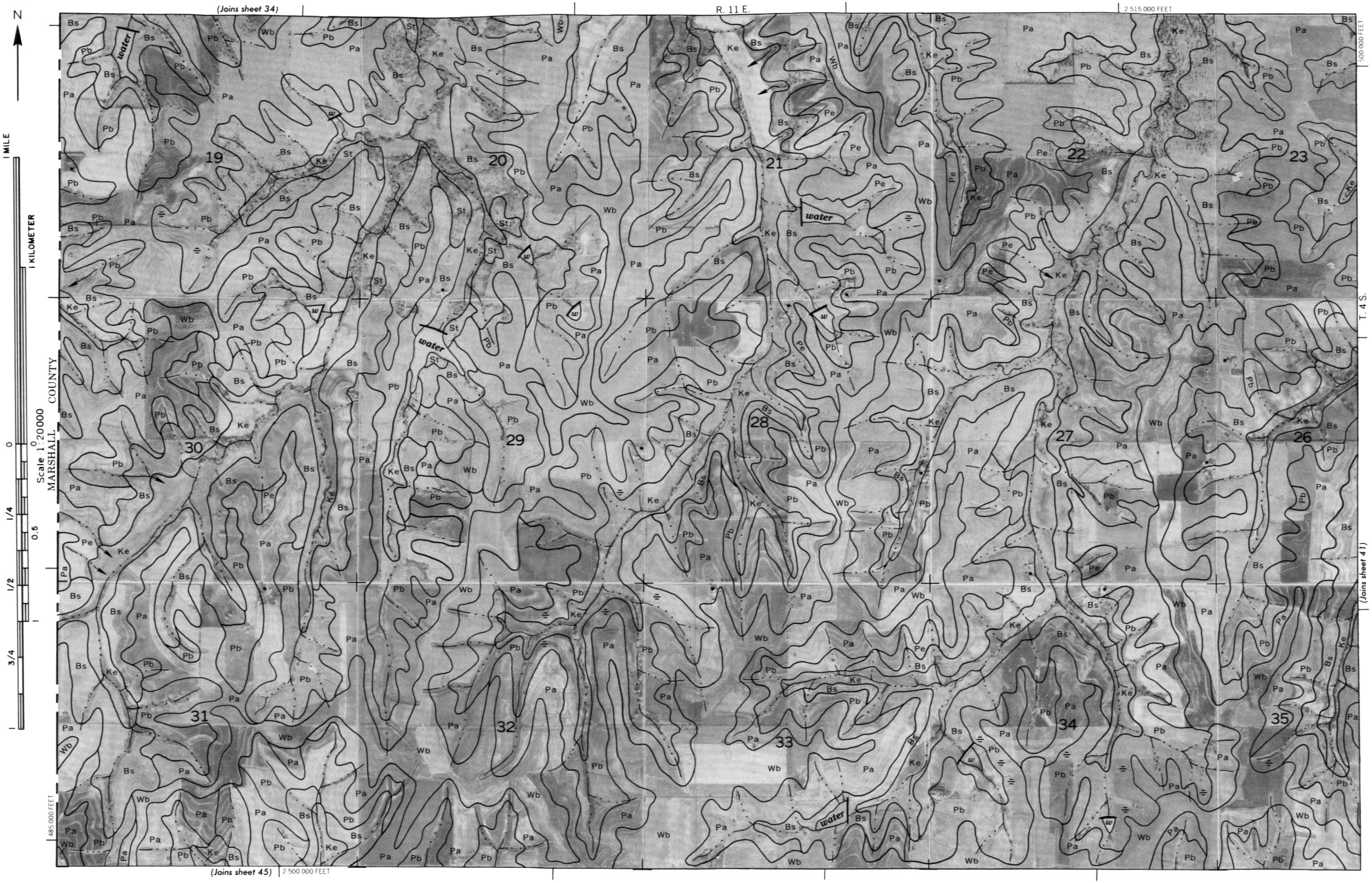
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 38

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 39

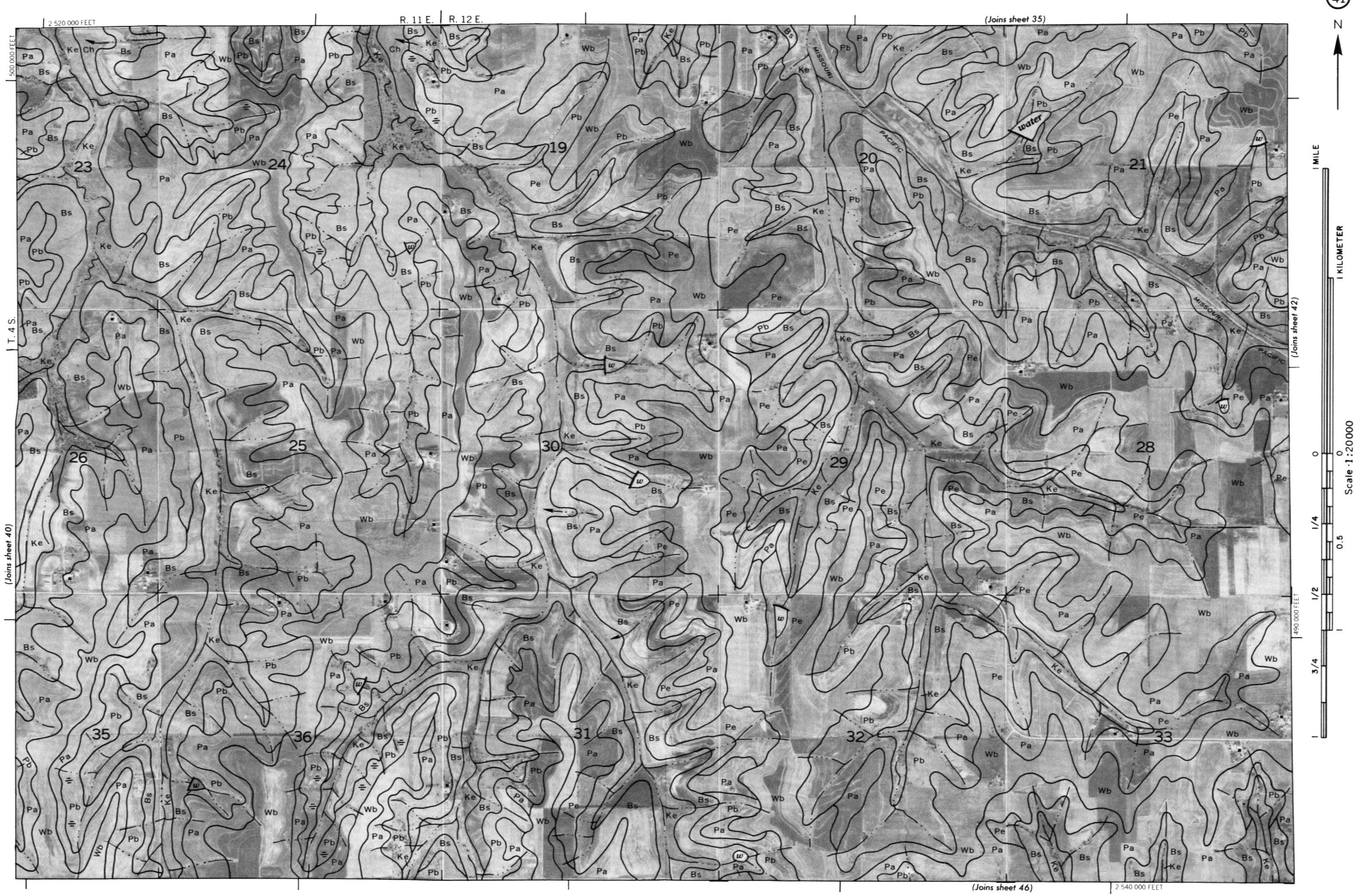




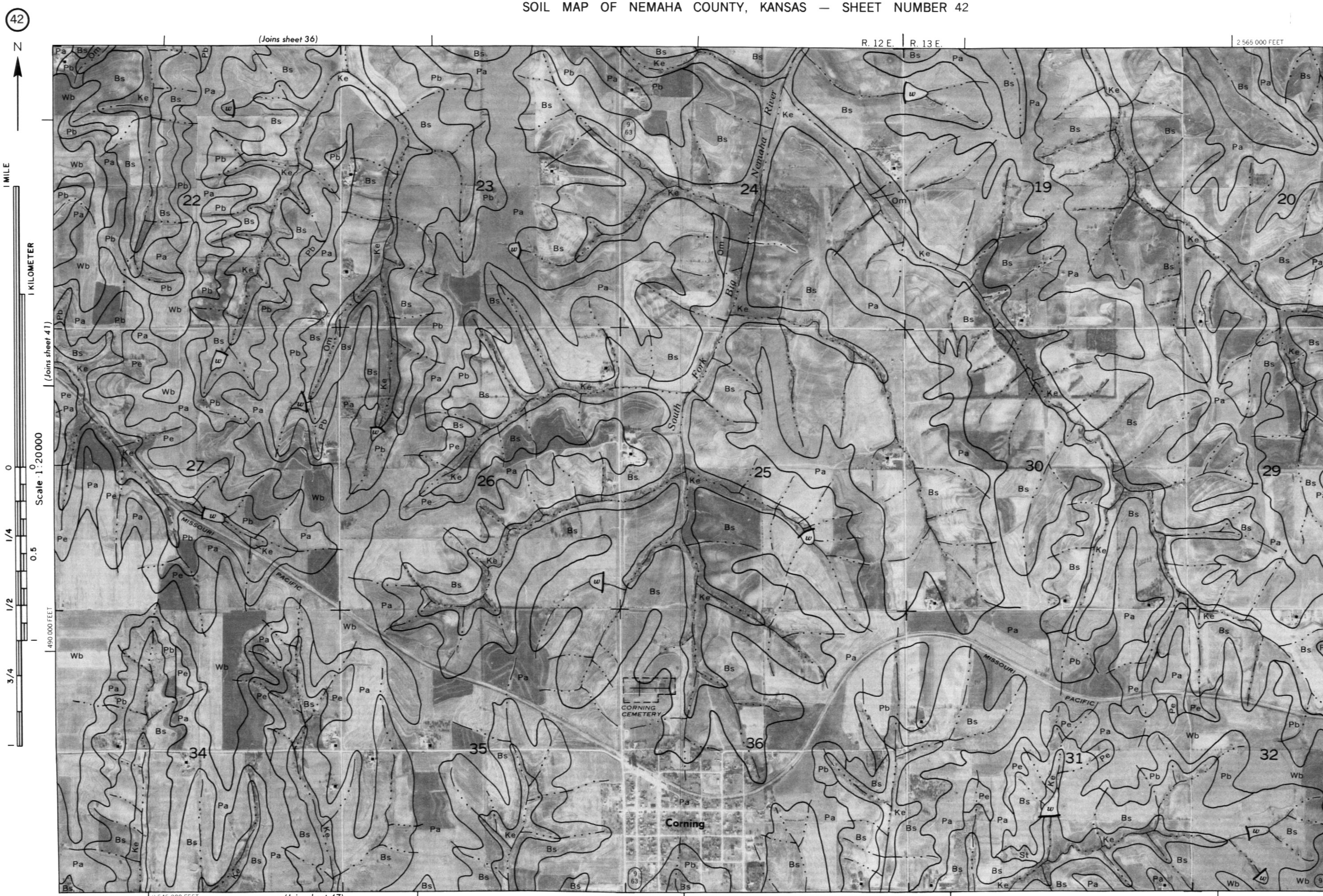
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 40

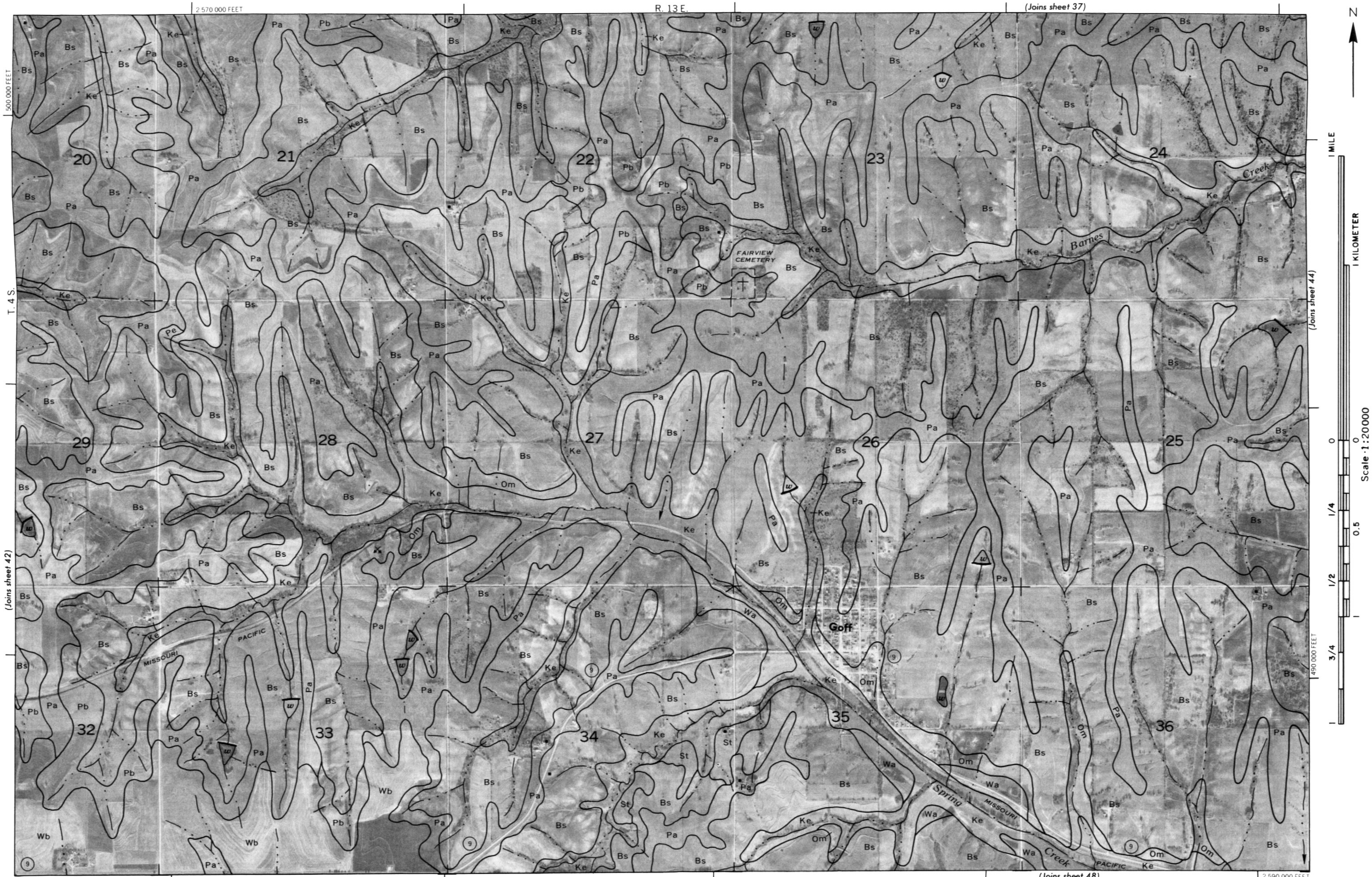


SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 41



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 42



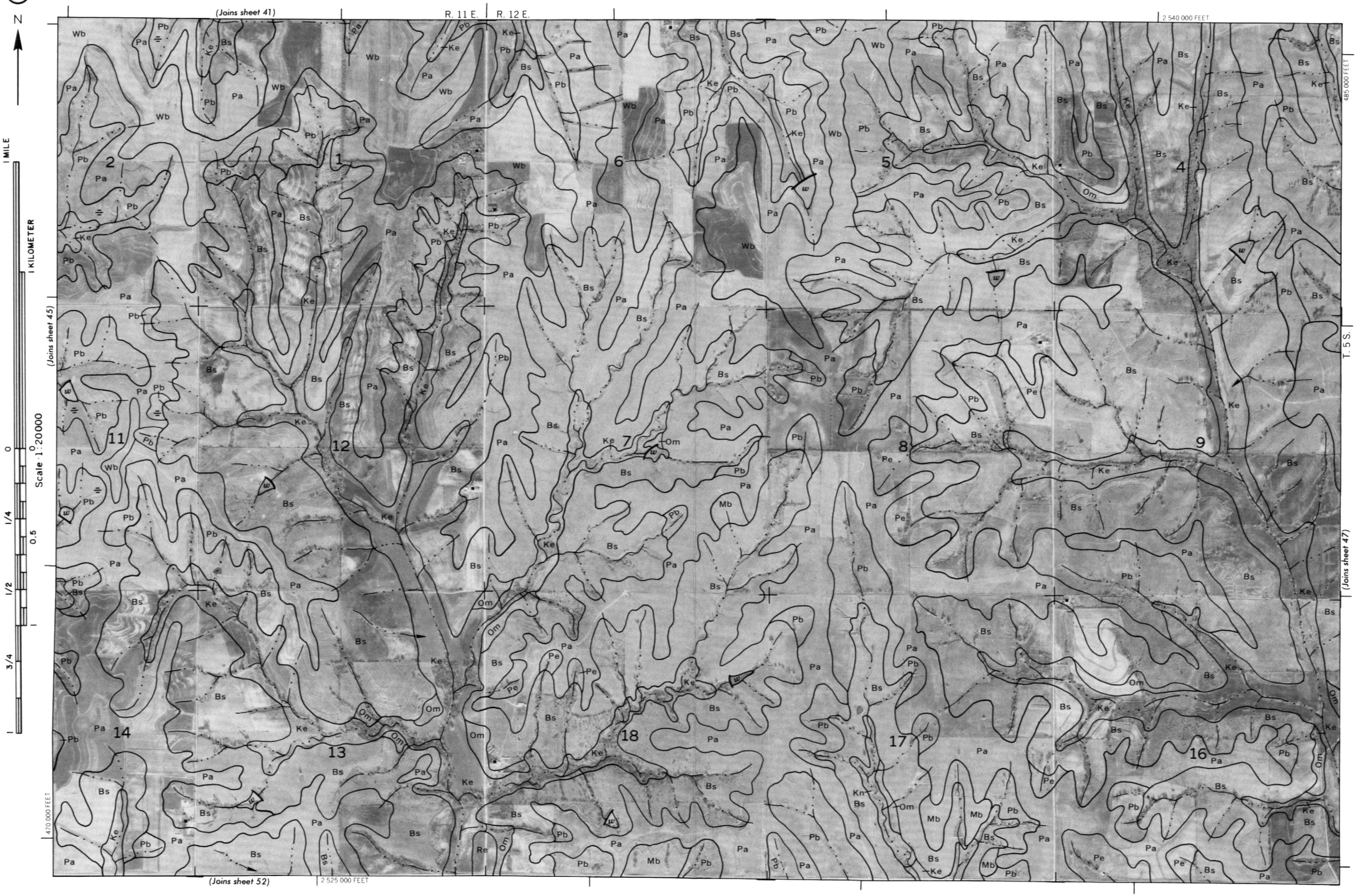

43
N
2 570 000 FEET
R. 13 E.
(Joins sheet 37)
500 000 FEET
T. 4 S.
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 48)
490 000 FEET
2 590 000 FEET
FAIRVIEW CEMETERY
Barnes Creek
Spring Creek
MISSOURI PACIFIC
Goff
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

44

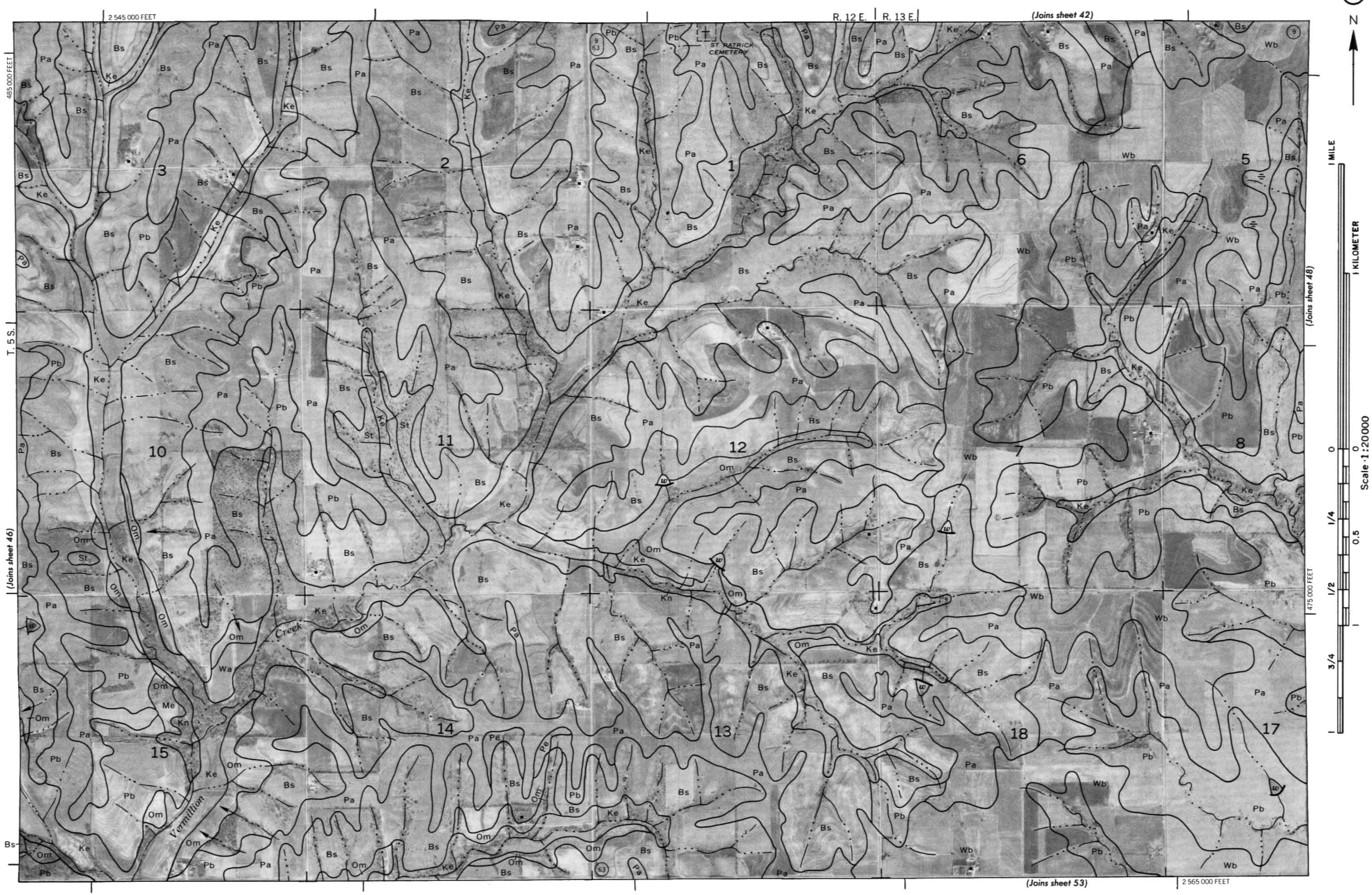
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 44

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 45

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 46



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 47



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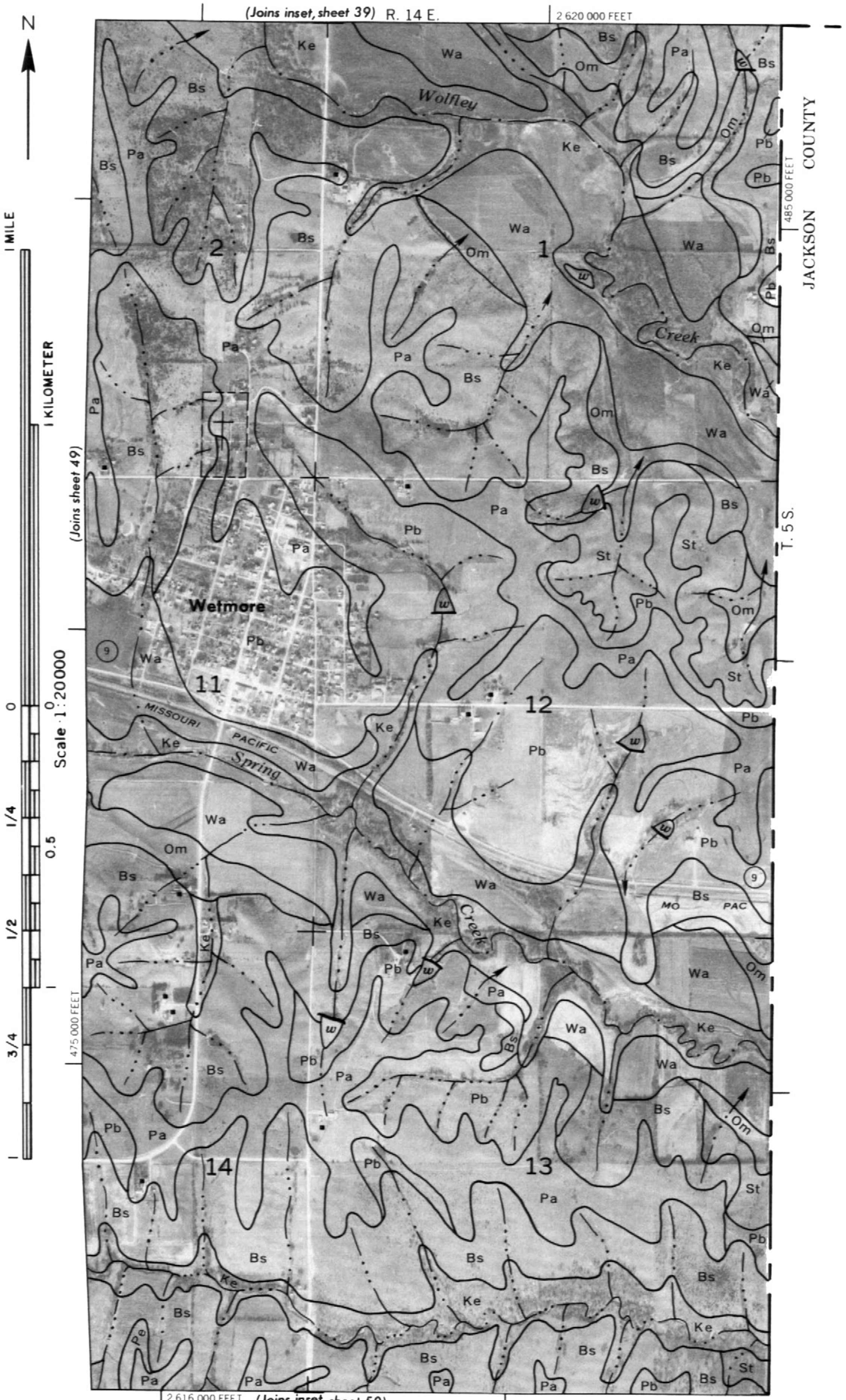
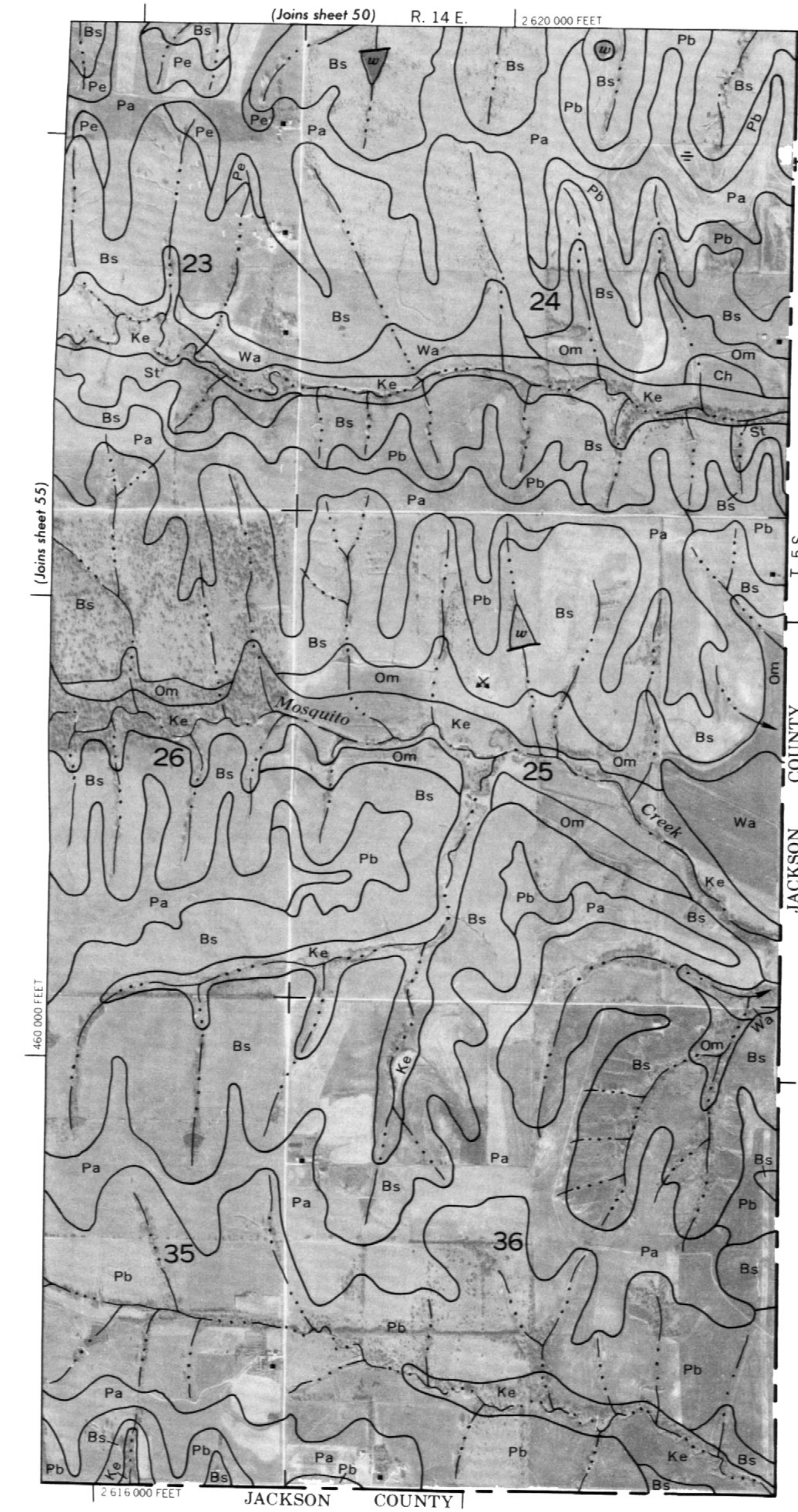
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 48

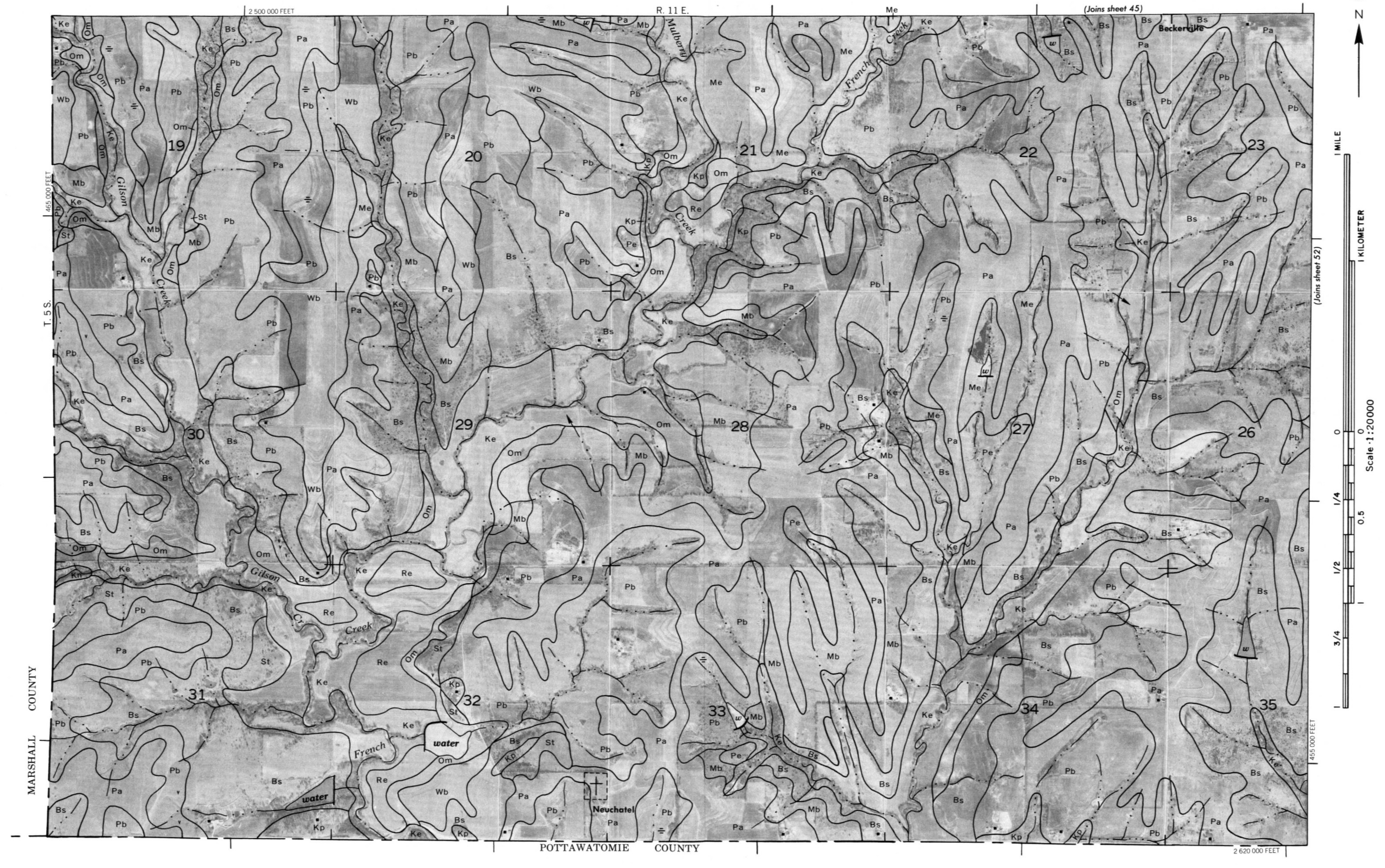
SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 49

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 50

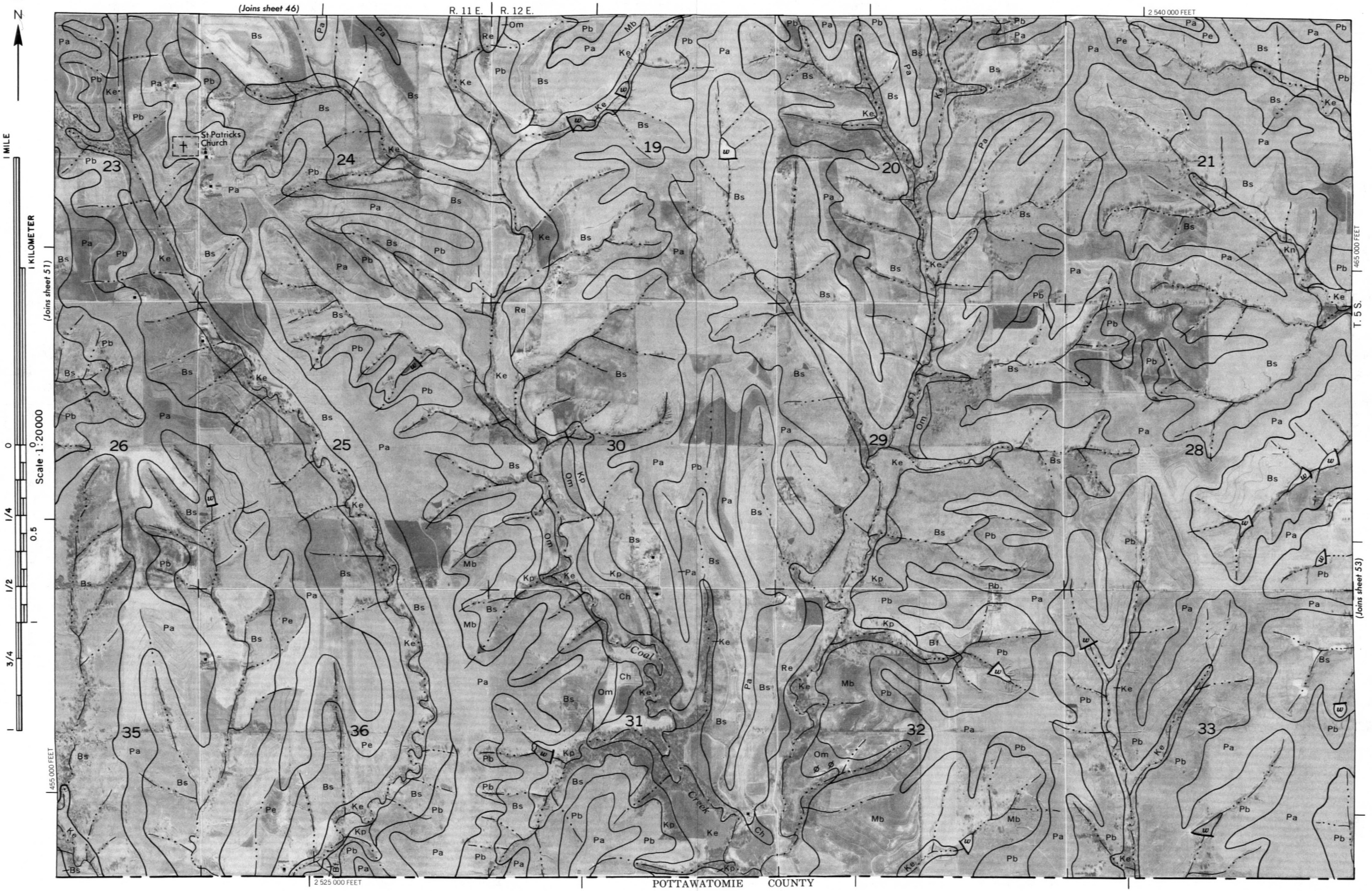




SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 51



SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 52




53
N
R. 12 E.
R. 13 E.
(Joins sheet 47)
(Joins sheet 52)
(Joins sheet 54)
2 545 000 FEET
2 565 000 FEET
465 000 FEET
455 000 FEET
T. 5 S.
Vermillion Creek
Wolf Creek
ROSE HILL CEMETERY
AMERICA CITY CEMETERY
POTTAWATOMIE COUNTY
JACKSON COUNTY
1 MILE
1 KILOMETER
Scale 1:20 000
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SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 54

SOIL MAP OF NEMAHA COUNTY, KANSAS — SHEET NUMBER 55